CHEMICAL & METALLURGICAL ENGINEERING

New York, N. Y., February 16, 1921 McGraw-Hill Co. Vol. XXIV, No. 7, 25c. a copy

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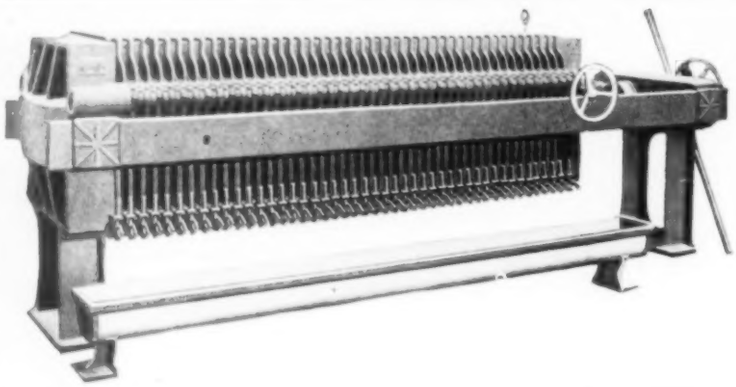

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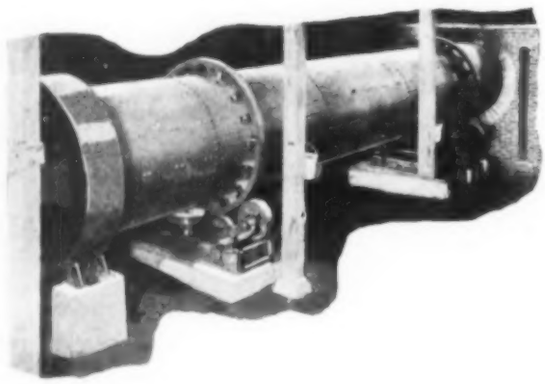

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

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Volume 24 | New York, February 16, 1921 | Number 7

Ignorance in High Places

IT CAN be stated almost with certainty that legislation to protect our dye industry will not be enacted at this session of Congress. Responsibility for the delay, however, can with no uncertainty be laid to the opposition of Senators THOMAS of Colorado and MOSES of New Hampshire. The former in particular is known to have a constitutional antipathy for tariff protection, while the latter is said to oppose the Longworth bill in the interest of certain textile manufacturers. Whatever may be their reasons, their power to obstruct legislation is so thoroughly recognized in the Senate that the committee having the matter in charge does not feel warranted in bringing it up.

Seldom do we realize all the forces at work in our legislative halls, nor can we always delve deeply enough into these forces to discover the animus behind them. Sometimes it is partisan politics, sometimes personal interest, sometimes prejudice, and sometimes plain ignorance of the subject. The last is not only incomprehensible but quite unjustifiable in a day when knowledge and information are thoroughly organized and readily available. Nevertheless we find a curious instance in Senator THOMAS' opposition to protection of the American dye industry. In response to our efforts to convert him to the necessity of legislation on this matter he assured us first of his thorough knowledge of the subject and then asked if we were not aware of the fact that "the small volume of German dyes now in course of production is dependent very largely upon intermediates supplied from the United States." This fallacy being thoroughly fixed in the Senator's mind, he sees no reason why, if we "are so frightened over the prospect of drastic German competition or Germany's speedy rehabilitation as a war power," we cannot "easily limit her production . . . by cutting off this supply." The Senator expresses the hope that he may "live until that policy is adopted." In the meantime, however, he stands stanchly against protection of the dye industry because it is a sinister piece of legislation, the ultimate purpose of which is to create a huge combination of chemical activities in the United States. With full faith that the desired protection will be consummated by the next Congress, the Senator bravely avers that "it will never be so long as I have strength to prevent it." The Senator retires on March 4. In the meantime it is to be hoped that if the next Congress declares peace by legislation, it will simultaneously extend the powers of the War Trade Board Section of the State Department so that dye importation can still be controlled by license until appropriate legislation is passed.

Participation of Technical Men in Public Affairs

WRITING at the close of his term of office on the subject "This Country of Ours," President BENJAMIN HARRISON gave a bit of advice too often ignored by professional men. He said:

> We have not realized in government, any more than in mechanics, inherent and perpetual motion. It is not enough to construct and start. Watchfulness, administration and love are needed to keep the best planned government on its projected lines. Men, rather more than machines, need watching.

There has been no time in the history of this country when more intimate attention to Government affairs was justified than at present. The chemist and the engineer, among others, have their responsibility clearly before them in these circumstances. Just now there are before Congress many important matters of legislation in which these technical professional groups are intensely interested. However, it is not enough to be simply interested in them; positive constructive action is required.

The recent experience of the chemical and engineering professions should justify all of us in venturing again into these legislative matters. Undoubtedly the effort made in the case of Patent Office legislation was the effective means for securing the favorable action on Patent Office salaries. The conferees from the House of Representatives and the Senate met with two salary scales before them. One was a distinct improvement over the present provision for the technical staff of the Patent Office, but even at that rather inadequate. The second provision cut the present limited staff in numbers and provided negligibly small increases for any grades in the staff. Under ordinary circumstances the result of conference on these two salary scales would have been a compromise; and, with the plea for economy sounding in the ears of all members of Congress, it is probable that the lower scale would have been adopted in most particulars. However, the technical men of the country, representing science and industry, demanded attention and as a result the members of both houses were convinced and have reported favorably upon the higher salary scale throughout.

In matters of dye legislation, chemical glassware importation (duty-free or otherwise), reorganization of the technical services of the Government, emergency tariff legislation, tariff revision, nitrogen legislation and other matters of this sort we find political factors which are beyond the experience of most technical men. With respect to these political factors we shall doubtless have to permit the professional politician to orate and finally to decide. There are, however, in each of these, and in numberless others, matters of technical

fact or of distinctly technical concern. With respect to these our professional engineers and chemists should be heard, and if they will but exercise "watchfulness, administration and love" they can and will be listened to attentively. The result will be a most satisfying participation in national affairs not only for the gratification of personal or professional desires but also for the general public welfare.

Chemical Warfare Service
An Investment for Economy

CHEMICAL warfare is the most effective, the most economical and the most thoroughly humanitarian arm of modern military service. It may seem anomalous to credit maximum effectiveness and humanitarianism to the same weapon, but it is a wholly justifiable anomaly.

Without effective defensive equipment for use in gassed areas, other arms of the military service are helpless. Within the range of even the "Big Bertha" troops cannot operate with impunity unless provided with defensive equipment adequate to cope with the most lethal gas which the enemy may choose to use. To send troops into the field without such equipment is worse than foolhardy. Yet that is substantially what the United States is proposing to do when it says to the Chemical Warfare Service that it may not expend each year a sufficient sum to develop, manufacture and replace from time to time with the most modern forms a supply of gas masks sufficient to equip perhaps three-quarters of a million troops within a period of thirty days. To send troops into the field with even the mask which was issued during the last months of the late war would be to place them in a defenseless position before any nation well equipped with the more modern types of gas shell. Yet that is precisely the condition which today is being authorized.

The Chemical Warfare Service has asked for a two-year period a sum approximately equal to 2½ per cent of the total estimated Army appropriation. The War Department itself cut these requests nearly in half, and Congress seems inclined to even greater "economy." It is worth while, however, to determine whether this is real saving or simply a penny-wise policy.

It is well recognized that in future military operations against a well-equipped enemy a very large percentage of hospital cases are certain to be gas casualties. Every such casualty on the field of battle represents a tremendous cost in money, a material reduction in effective fighting strength and a large increase in the medical and hospital personnel and facilities. It is a well-known saying among military men that every wounded man requires two well men to care for him. And this is no exaggeration. Every ineffective mask is, therefore, potentially responsible for three persons rendered *hors de combat*.

The effectiveness of gas in modern warfare need not be emphasized. It is worth while, however, to recall again the fact that there is a much higher percentage recovery from gassing than from any other type of casualty. Thus one can well defend the claim that it is the most humanitarian of all means of attack upon combatants.

The chemical industries should appreciate the important points which can be made in support of chemical warfare. This type of warfare is really available only to a civilized nation of high industrial intelligence. The industries of any nation developing chemical warfare to a full state of effectiveness will find simultaneous advantage to industry through the incidental organic chemical research. Indeed this alone probably would justify the expenditure. But more than this, industry can rest assured that if the nation is thoroughly prepared in this respect no other country has an opportunity effectively to attack us with hostile motive. Industry is thus both directly benefited and indirectly protected, and may well ask why the Chemical Warfare Service should not be provided with at least 2 per cent of the estimated Army expenditure, which is the very modest request the Service is making.

The Right Way
To Do It

THE Committee on the Chemistry of Colloids of the Division of Chemistry of the National Research Council has issued a list of about 200 research problems prepared by Prof. WILDER D. BANCROFT, of which forty-five were published in the January number of the *Journal of Industrial and Engineering Chemistry* of the American Chemical Society, and forty-eight more in the February number of the same magazine. The list was issued last November, and it is hoped that the serial publication will be completed in April or May.

The work was undertaken to stimulate research, and the method has proved to have great merit. Of course it would be hard to find the equal of Prof. BANCROFT in the exposition of problems, but it goes without saying that these may serve as a pattern for others. No sooner had the first forty-five been published than letters began to pour in to the chairman of the committee, Prof. HARRY N. HOLMES, at Oberlin College, Oberlin, Ohio. For instance, an industrial chemist wanted to "team" with a university man better versed in theory than he, in regard to a problem in the chemistry of paints. Some men are asking for specific problems that they fancy. A prominent manufacturing company asks, in regard to one of the problems, to be put in touch at once with any good chemist who has selected it for his own research. It says it has some helpful information that it will put at his disposal. Here is the very thing that academic men accuse industrial concerns of not doing. They ask them to hand out results of their research, and lo and behold, it is done!

"Why," asked a chemist of Dr. HOLMES, "don't men in other fields of chemistry do the same thing: put out lists of stimulating research problems?" Well, why don't they? We've always been in favor of such a procedure, and in an editorial on "Metallurgical Mysteries" in a late number we intimated a number of such problems in the metallurgical field.

We congratulate the National Research Council on the sanity of the method of the Committee on Colloids and on the subtle intelligence with which the committee transacts its business. The open publication of problems reaches the man who wants to do the job, who has a leaning for it. It touches the person in whom the fires of enthusiasm are already burning. Instead of being assigned to a chemist, it is chosen by him; chosen because of his faith in his own ability to do this very thing. That is sound psychology.

Suppose instead of this direct, sincere work, the committee were to sit in high conclave and determine who is best fitted for each problem and then to allot them accordingly? Even if the committee sat on the top

floor of the Bankers' Trust Building, surrounded with Gothic tapestries, and rested in chairs specially imported from the Musée de Cluny, and smoked two-dollar cigars, it would still lack the pentecostal light to lead it unto wisdom. As likely as not its members would forget the one man in all the world who is best fitted to undertake it, who is, very possibly, making urine analyses for the country doctor to help out his salary as professor of chemistry at some Deepwater Baptist College in a town they've hardly heard of. But that one man does know, and as soon as he reads the call he answers it.

To our mind the Committee on Colloids is on the right track. Or, to mix our metaphors, we might also express the opinion that it is leading the band.

The Function of Educational Institutions in Research

SEVERAL weeks ago we attempted a delineation of two types of research, scientific and industrial, and suggested what seemed to us a logical allotment of those types to agencies best suited to conduct them. Briefly, the conclusion was reached that scientific research is best fostered in the laboratories of universities and government bureaus, while industrial research had best be left to commercial laboratories and consultants. The line is not drawn hard and fast, because it is recognized that industry may see fit to conduct scientific research of the highest order and that occasionally university and college laboratories may properly be devoted to the solution of industrial problems. The general distinction, however, we believe to be sound and in the best interests of all concerned.

An organization like the Mellon Institute is outside the scope of our criticism because it stands practically by itself and it is doubtful if commercial laboratories would fill the same need in the same way. Probably the success of the Institute has suggested the adoption of industrial fellowships at other schools, but it is not likely the same success will be attained elsewhere. The Mellon Institute had its inception in the mind of a far-seeing leader, and its realization was dependent upon financial support of such magnitude as is unlikely to be readily obtained.

The relation of universities and industrial research may be further discussed in view of the recent tendency on the part of some of our institutions of learning to establish industrial fellowships and engage in research and consultation. This attempt to combine two entirely different types of work in the same institution, and often under the same direction, must inevitably lead to an *impasse*. The primary function of the university is the education of its students. Presumably this education consists in the inculcation of broad elements of culture and the exposition of fundamental principles. The purpose and methods are quite distinct from those of industrial research having as its ultimate goal the discovery or improvement of a process or product. We doubt if the two can be prosecuted successfully side by side. One is likely to be subordinated to the other, and suffer in consequence. If the attempted service to industry is to be successful the institution must develop into a consulting organization to the detriment of its teaching function, while if the latter be exercised in the highest degree any attempt at industrial research is likely to prove abortive. If instruction suffers the result will be poorly equipped graduates whose field of endeavor has been narrowed by the almost certain prospect of competition with their own alma mater.

The whole question of competition between universities and their alumni looms up in this connection. It is argued that when universities enter into competition against established consultants they can usually underbid the latter by the offer of free laboratory service and the assistance of industrial fellows whose salaries are modest, but probably commensurate with their abilities. The result is unfair competition which affects not only the private consultant, who may be an alumnus of the institution, but also the industrial fellow who may be working on a problem beyond his capability, the instructor who divides his time between theoretical instruction and supervision of industrial research, the student who possibly suffers from this division of effort, and finally the company or organization supporting the research, due to possible dissatisfaction with the results of poorly planned or ill-advised investigation. The last is greatly to be deplored because it is likely to deter the other companies from undertaking industrial research and thus retard the progress of industry. In general it seems that the whole matter of industrial fellowships in universities would profit from a searching examination as to purpose, influence on instruction and value of commercial results. We believe it will be found that the search for the truth and the search for the dollar are different occupations and that their paths are not the same.

But if we do not regard industrial research as a legitimate activity for universities we are none the less confirmed in our opinion that there is a vast number of scientific research problems which they should undertake and which ultimately would inure to the benefit of industry. These relate to the fundamental data, properties, constants, etc., which are so badly needed by those who apply science in our technological industries. They are of the type discussed in our last Chemical Exposition number by Prof. RICHARDS, and subsequently by DONALD M. LIDDELL. It is just the sort of research which should make less arduous and difficult the work of the National Research Council in gathering data for American tables of chemical and physical constants. In fact there is enough scientific research to be done to keep a far greater number of men busy than are now engaged in it, and the place for it is in the atmosphere and surroundings of the university laboratory.

Another type of research which is quite within the scope of the university is of a semi-public character which is not likely to be undertaken by individuals or companies but from which they and the general public will profit. A typical example is the work undertaken by Dr. WITHROW at the University of Ohio in the study of the nuisance resulting from fumes from chemical manufacturing plants. Such an investigation will serve the state, the immediate community and the industry. Problems of this kind relating to public health or welfare undoubtedly exist in many communities and can be undertaken by universities, particularly if supported by the state. In general we feel that in deciding whether or not a certain line of research is legitimately within the field of the university a safe criterion will be the existence or non-existence of other suitable agencies, corporate or individual. With this in mind universities will find little excuse for excursions into industrial research, just as they will find little competition but much approval for their efforts in scientific research.

Readers' Views and Comments

Sulphur Dioxide May Have Therapeutic Value

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your Dec. 15 number is an article "Chlorine May Have Therapeutic Value." Sulphur dioxide gas may have a similar property. During the influenza epidemic of 1918, the working force of the British Acetones Co. at Toronto, Ont., was reduced nearly 30 per cent by cases of influenza, but in the sulphuric acid department not one of the eight men employed there suffered from it.

S. A. IONIDES.

Denver, Col.

Duty-Free Apparatus for Colleges

To the Editor of Chemical & Metallurgical Engineering

SIR:—I note in your issue of Jan. 12 that Prof. J. W. Richards, in opposing the repeal of the duty-free importation privilege now possessed by our educational institutions, says: "Let's have a broader vision and have a further look ahead."

After reading Prof. Richards' arguments I was really surprised at his own very limited range of view in this respect. A look a little further into the future than Prof. Richards seems to have taken would disclose the fact that in the long run a properly protected industry in this country has, almost without exception, resulted in the development here of cheaper and better material than that previously imported from abroad. With this in mind, it seems clear that eventually if the manufacture of chemical supplies is properly protected here our technical students will have not only a better and cheaper supply but one near at hand.

This will result in much greater convenience in obtaining supplies and prevent what has occurred during the last six years—a complete cut-off of all supplies of this kind. Technical students then will never again be "hampered" in their training as they have been for the past six years and still are today. A duty on such supplies may cause annoyance for a short time, but ultimately they will undoubtedly be made better and cheaper here and the purchasing power of the educational funds will not be decreased but made greater in the long run. All of this will be conducive to increased efficiency in technical education.

It may be that for some time certain kinds of apparatus will not be made here, but eventually they will be and the amount of tariff paid by our educational institutions for these few items will certainly not constitute a heavy drain on their resources. They would also get a partial offset by cheaper freight rates. A tariff does not shut out foreign articles and hence would not prevent those who want to use foreign apparatus from doing so if they wish. An appeal to the patriotism and good judgment of the friends and alumni of any institution of higher learning that finds itself hampered by the increased cost of material due to a protective tariff on goods of American manufacture, levied for the purpose of developing American independence in such material, would certainly bring a response which would more than compensate for any temporary increased cost or embarrassment to the college.

I am sure when Prof. Richards gets a truly "broader vision and further look ahead" he and others of his view will not fail to see the advantages of developing our own supply close at hand and insuring against all future holdups of such materials by any foreign country.

ALBERT W. SMITH.

Department of Chemistry,
Case School of Applied Science,
Cleveland, Ohio.

Water Purification

To the Editor of Chemical & Metallurgical Engineering

SIR:—"A Comparison of Various Methods of Water Purification," by William Macklin Taylor, in your issue of Jan. 19, is of much interest and contains many suggestions which should be valuable when considering water softening.

As Mr. Taylor very properly states in concluding his article, ". . . it is apparent that each type of water purification has a fairly well-defined field in which it is unquestionably *best*." Speaking frankly from a precipitation water-softener standpoint, it seems to me that he claimed too much breadth of field for the admittedly discredited boiler compound method of softening.

The "soapy taste" which Mr. Taylor states is characteristic of lime-soda softened water is something which is foreign to the experience of the citizens of Columbus, Ohio; McKeesport, Pa.; Owensboro, Ky., and many other municipalities where softened water is used for domestic purposes. The complete satisfaction afforded by these and other lime-soda purified supplies scarcely checks with Mr. Taylor's sweeping statement in regard to the unfitness of lime-soda softened water for domestic use.

Small boiler installations where less than 500 gal. per hour of water is evaporated are not readily covered by the continuous type of lime-soda softener. For this service an intermittent or batch type of softener is particularly well adapted.

There is no doubt that certain substances can advantageously be added to water in boilers for the purpose of diminishing foaming and that certain others may be used to counteract electrolytic corrosion. This kind of treatment, however, has nothing to do with water *softening*. Where actual water softening is concerned—and the removal of calcium and magnesium salts from the water is required—the elimination of these objectionable substances by precipitation methods is universally conceded to be the best.

Practically every boiler plant engineer and certainly all steam railroad water service engineers have tried the boiler compound method. Of course they have used the most effective chemicals known as well as the "worthless components." As a last resort in preparing water for boiler feeding they turn to precipitation methods, as is witnessed by the increasing numbers of these plants being installed. The net result is that some railroads are already completely equipped and additional softeners are being installed elsewhere as rapidly as funds become available.

L. M. BOOTH.

Elizabeth, N. J.

The Cordage Fiber Industry of the Philippine Islands

Description of the Production of Manila Rope Fiber From the Abaca Plant—Opportunity for Industrial Advances — Agricultural and Botanical Notes—Yield, Methods of Manufacture and Products Obtained From Fiber

By DR. ALVIN J. COX*

ABACÁ (Manila hemp), the most important and valuable fiber and export product of the Philippine Islands, is the foremost commercial cordage fiber in the world. High-grade machine-laid ropes made from it usually have a tensile strength of more than 15,000 lb. per sq.in. Statistics given for abacá for 1919 by the Director of Customs for the Philippine Islands show that it comprised about 40 per cent of the total value of the exports and amounted to 121,247,668 kg. (267,305,034 lb.), valued at $26,851,825. The last report issued by the same bureau covering the first six months of 1920 gives 86,891,232 kg. (195,175,085 lb.) valued at $21,972,175. It was still in the lead in value as an individual export product, though the recent increase in the production of coconuts, tobacco and sugar cane which are exported as copra and coconut oil, cigars and in other forms, centrifugal and raw sugar, respectively, have reduced the percentage. The purchaser is now protected in the abacá materials which he buys due to government supervision and grading.

Growth of Exports

Abacá was first exported to the United States from the Philippine Islands early in the last century and from that time on the use of the fiber has been very popular and has rapidly extended. The Philippine Bureau of Agriculture Bulletin 12, pages 9 and 10, says that the first authentic account of the use of abacá or banana fiber in the Philippines is that given by an Englishman, Dampier, who lived in the Island of Mindinao in 1686; that in 1820 a sample of abacá was brought to Salem, Mass., by John White, a Lieutenant in the Navy, and that from 1824 to 1827 the fiber began to be used quite extensively in Salem and in Boston. The figures in the accompanying table indicate the increase in production and exportation since these became of importance:

EXPORTS OF ABACÁ FROM THE PHILIPPINE ISLANDS

Year	Kg.	Lb.	Value in Dollars U. S. Currency
1850	7,700,000	17,000,000	.....
1860	27,000,000	37,500,000	.....
1870	28,500,000	62,830,000	.....
1880	46,000,000	101,500,000	.....
1890	62,700,000	138,230,000	.....
1900	81,600,000	179,900,000	12,240,000
1910	170,788,629	348,219,990	17,404,922
1920	86,891,232*	195,175,085*	21,972,175*

* For the first six months.

Species of Plants

The name abacá is applied not only to the fiber but to the plant from which it is obtained. Abaca *Musa textilis née* closely resembles the common banana *Musa sapientum* in appearance and habits of growth, but may be easily distinguished from it by its narrower, more tapering, and darker colored leaves. Plantain *Musa paradisiaca* is also a closely related species. The common banana produces a fiber similar in appearance to that from abacá but lacking in tensile strength. The fruit of the abacá somewhat resembles that of the banana but is smaller, full of black seeds, inedible and of no economic value. Abacá fiber frequently is called Manila hemp and is generally known to the trade by that name. However, it is not hemp and this designation is misleading. Hemp is the fiber produced by the plant *Cannabis sativa*. The two are quite different. Abacá is a hard, light, strong, resilient, durable structural fiber as described below, whereas true hemp is a tough, fibrous layer between the wood and the bark known as bast fiber which is characteristic of certain

*Director, Bureau of Science, Government of the Philippine Islands, Manila, 1912-19.

families of plants. In the Philippines there are many bast fibers that have an extensive local use as a substitute for abacá and in some parts of the islands—for example, the Ilocano provinces—the making of rope from bast fibers has a considerable commercial importance. When much exposed to moisture some bast fiber ropes are superior in durability to abacá rope and in a few cases have a breaking length—i.e., the breaking load divided by its weight per unit length—closely approaching that of high-grade machine-laid abacá rope.

The Abacá Plant

The true stem of the abacá plant has a diameter of about 2 in. and is that part which bears the fruit. The flower bud remains at the root until the plant has attained about its full size and then pushes rapidly upward. The stalk or trunk is formed by this true stem and the thickened petioles of the leaves which form overlapping layers around it, and the plant grows to be from 15 to 35 ft. high and a foot or even more in diameter.

The abacá plant has a perennial root, and may be grown for many years without replanting. As the stems mature the root sends up numerous suckers which make the subsequent stalks, so that after a time the plants no longer remain in accurate rows. The time required for development varies with different varieties and in different localities. Generally cutting may be begun in about two years after the original planting, and after three years a plantation should be in full bearing. It is customary to cut a plantation about every four to eight months and from two to four stalks per plant can be harvested at a time. All stalks do not mature at the same time. The stalk is ready for cutting between the time of appearance of the flower and the development of the fruit. If cut before or after this period an inferior quality of fiber will be obtained. When the plant is in flower the large violet-colored flower bracts fall to the ground and make it easy when passing through a field to select the plants that are ready to be cut.

FIG. 1. VIEW SHOWING GROWN ABACÁ PLANTS IN BLOOM SURROUNDED BY YOUNG SUCKERS

The stalk is cut on a slant 2 or 3 in. above the ground with a sharp bolo or large knife. A horizontal cut is to be avoided, for then water will collect on the stump and cause it to rot and thus injure the root and the remaining shoots.

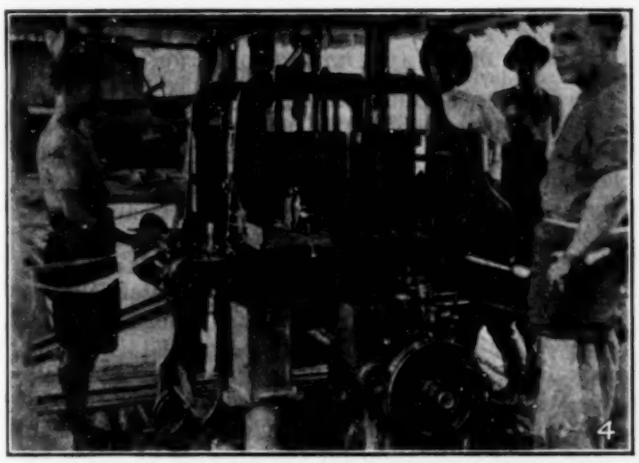
Preparation of Abacá Fiber

The fiber comes from the petioles and the quality varies with the different layers. That from the outer layers is usually coarse and dark colored. After the leaves have been trimmed from a stalk the petioles are separated one from the other and split into strips, the fiber being obtained from the outer portion of these strips. The next step is to insert a small sharp piece of bamboo or bone into a strip of petiole and, after starting the separation of the fibrous portion, pull it off in ribbons as long as the strip. The remainder of the strip is discarded. When a quantity of these ribbons has been collected it is pulled under a knife to remove the fleshy material from the individual fibers. The knife is held horizontally, serves as a scraper, and when it is desired to insert or remove a ribbon of fiber it is lifted by a crude spring controlled by a foot treadle. Every ribbon is passed under the knife twice, the second time to strip the end that the operator grasped during the first pull. As the abacá stalk contains a large percentage of water and is very heavy and the stripping equipment is light and easily transported, the latter is usually moved from place to place and the fiber extracted near the spot where the stalk is felled. The cutting and stripping should be done on the same day, else the petioles deteriorate and yield a dark-colored and inferior fiber. After the fiber is stripped it is hung on a pole, generally bamboo, in the sun to dry. The more quickly it is dried the whiter and more lustrous the fiber.

Numerous attempts have been made to extract abacá fiber with machines and a number have been used with a measure of success, but the major portion of the abacá fiber produced in the Philippine Islands is hand-stripped. The cleaning of the fiber, which is controlled by the condition of the knife blade, the pressure with which it is pressed against the block and the drying are very important, for upon them depend the important qualities of both strength and color. A method of stripping must not break, tangle, discolor, waste or in any way injure the fiber.

When thoroughly dry the fiber is tied into bundles and brought together into central warehouses, where it is carefully sorted into the different commercial grades and baled for export. In the final baling a certain amount of oil is generally used on the fiber.

The best marine cordage, oil-drilling rope, binder twine, trawl line, etc., are made of abacá. Although the chief use of abacá is as a cordage fiber, the conclusion should not be drawn that it is not suitable for other purposes. Abacá is used either in its natural color or dyed in the manufacture of matting, hats, bags, baskets, trays, slippers, belts, lamp shades, cloth, lace, etc. Abacá cloth is a gauzy fabric known as sinaway and is



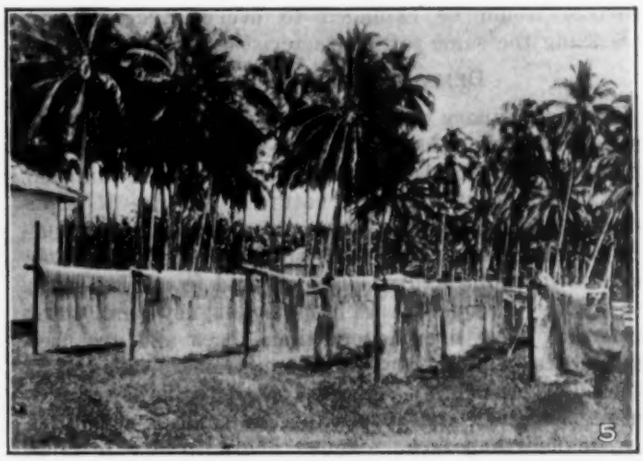


FIG. 2. SEPARATING THE LAYERS OF PETIOLES
FIG. 4. BEHRENDT ABACÁ STRIPPING MACHINE IN OPERATION
FIG. 6. DELIVERING HEMP TO WAREHOUSE

FIG. 3. STRIPPING FIBER FROM STALKS
FIG. 5. DRYING AND CURING THE ABACÁ FIBER
FIG. 7. PRODUCTS MADE OF ABACÁ, INCLUDING ROPE, HEMP, ETC.

much used by Filipino women for camisas (waists). Sometimes cotton or silk is woven with the abacá to make exceptionally beautiful fabrics.

COMMERCIAL CENTERS

The exportation of knotted abacá is an important industry in Cavite, Batangas, the Bicol and certain other provinces. There are also factories in Manila for manufacturing the tied abacá fiber into braid of various widths. The braid as well as knotted abacá is exported to Europe and Japan for the manufacture of ladies' hats, which are made by sewing strands of braid together. Abacá hats are also manufactured in the Philippine Islands.

There are many different varieties of abacá, frequently a dozen or more in a single locality. The principal differences between them are in color and shape of stem, color and size of leaves, greater or less tendency to produce suckers, resistance to drought, and in development, strength, delicateness and quantity of fiber. It is desirable to secure an abacá plant which is hardy, grows rapidly and withstands drought, which has a long, thick and not too tapering stalk, and which produces fiber in abundant quantity, of good quality and easily extracted.[1]

The abacá plant is peculiar in that it cannot be grown

[1]From Philippine Bureau of Agriculture Bulletin 12, p. 11.

elsewhere than in the Philippine Islands. Experimental plantings have been made in Borneo, India, the West Indies and other parts of the world. In some instances the plants grew fairly well, but the fiber was inferior. Abacá requires a uniform warmth without excessive heat for its best development. A cold climate will retard not only its growth but the development of the fiber as well. Heavy winds have to be avoided, for they seriously injure the heavy, broad leaves. Only in the Philippine Islands has the fiber ever been successfully produced as an article of commerce. This fact undoubtedly has been of great benefit to the Philippine planter. However, the lack of competition has resulted in the continuance of antiquated methods of cultivation and fiber extraction. There are still many differences in agricultural practices in the various provinces. With keener competition the best methods used by any province would be extended to every other district possessing the same soil characteristics.

Demand Exceeds Supply

Even in ordinary times the abacá supply is insufficient and is constantly exceeded by the demand. Since the outbreak of the World War there has been an unusual shortage of abacá fiber and naturally the use of other fibers has been extended. There also has been an inclination on the part of some to use cheaper fibers wherever possible in manufactured products and to market them as abacá. Frequently Philippine maguey and other structural fibers are cheaper than abacá and are used as diluents in abacá rope and similar materials. It is impossible accurately to differentiate microscopically between maguey and abacá, and the small abacá fibers are smaller than large maguey fibers. Color tests to distinguish between abacá and other fibers have been developed by the Bureau of Science. A satisfactory method of staining has been devised which gives distinctive colors, such as golden yellow for abacá and pink for maguey.

Abacá is not grown generally throughout all the Philippine Archipelago, though it is distributed throughout the greater part, and its commercial cultivation is restricted to certain favorable districts where there are deep, mellow, fertile, well-drained soils, freedom from winds, a high humidity and an abundant rainfall uniformly distributed throughout the year, where it attains its highest development. Such natural agencies as temperature, amount of light and sunshine, winds and the evaporation of the soil moisture, exposure, altitude, humidity, the amount and distribution of the rainfall and other climatic and physical conditions exert an influence either favorable or unfavorable and are of as great importance in the production and quality of abacá as the inherent characteristics of the soil itself.

Conditions Required for Growth

The structure of all banana plants and their habits of growth are such that a large and constant supply of moisture is required. The humidity which regulates plant transpiration is only second in importance to rainfall. In districts having a long and definitely defined dry season the cultivation of abacá cannot be carried on successfully unless a ground water table at an even depth or a practically constant available water supply in the soil can be maintained by irrigation.

In a paper entitled "Philippine Soils and Some of the Factors Which Influence Them,"[2] I pointed out that not only is a rainfall well distributed throughout the year a condition absolutely essential to the success of certain crops such as abacá, coconuts, tobacco and rubber, but this distribution also controls the prevalence of certain species of plants of the native vegetation. A map upon which was charted the provinces with 5 per cent or more of total cultivated area in abacá, coconuts and tobacco differentiated the Philippine Archipelago into the western region having a prolonged dry season and the eastern and southern having a rainfall well distributed throughout the year about as accurately as one in which these two different types were plotted immediately from meteorological records. Some variation is noted in the eastern part of the islands due to the topography of the regions, but there is sufficient rainfall during even the driest months so as not seriously to interfere with abacá or other stable crop dependent on continuous rainfall.

1,000 Acres Under Production

Abacá may be cultivated up to 3,000 or 4,000 ft. above sea level, but above this height the temperature is not favorable to its best development. The most favorable locations are along the eastern and southern coasts. The most important provinces, sub-provinces and islands in order of the importance of their production are as follows: Leyte, Albay, Sorsogon, Ambos Camarines, Samar, Davao, Misamis, Surigao, Oriental Negros, Cavite, Zamboanaga, Cebu, Laguna, Tayabas, Mindoro, Capiz, Agusan, Bohol, Romblon, Occidental Negros, Panay, Batangas, Antique, Lanao, Palawan and Cotabato. It is grown to some extent in other provinces of Luzon and on many of the smaller islands. The amount of land under cultivation for the growing of abacá has been estimated at about 1,000,000 acres. It is quite difficult to get an accurate estimate, because the plant often is grown on small and widely scattered areas in remote places.

Little Cultivating Required

In the best plantations there are usually about four hundred to five hundred plants to the acre, but the exact number varies with the character of the soil and the variety of abacá grown. Frequently camotes (native sweet potatoes) are set out at the same time or other crops are planted which grow rapidly. This system is advantageous in that the growth of weeds is prevented and the loose soil is not washed away where the land is sloping. Where the soil and other conditions are favorable, abacá may very profitably be grown on the same ground with coconuts until the latter come into bearing. Under the present system little cultivating is done except to keep the land clear of grass and weeds. As the abacá matures it shades the ground and the grass and weeds are much less.

Typical Analysis of Soil

The use of commercial fertilizers has thus far not been extensively practiced. The abacá lands as a class are very fertile and probably will not have to be fertilized for a long time to come. An analysis of soil from one plantation in the Cotabato Valley taken for purposes of illustration is as follows:

Constituent	Per Cent
Moisture (H_2O)	7.39
Loss on ignition	13.20
Nitrogen (N)	0.276
Phosphoric anhydride (P_2O_5)	0.201
Lime (CaO)	0.31
Potash (K_2O)	0.27

[2] *Philippine Journal of Science*, Section A (1911), vol. 6, No. 4.

The enemies of abacá, such as insect pests and plant diseases, are very few and the total damage which the plants suffer from such causes is very little and in the aggregate entirely negligible.

Yield of Fiber

The yield of fiber varies greatly depending upon the variety grown, the soil, climatic conditions, efficiency of the method of extracting the fiber, etc., but usually from ½ to 1 lb. of fiber per stalk may be obtained. Under ordinary conditions the annual yield will average about one-half ton of dry fiber per acre. The figures given at the outset of this paper for the first six months of 1920 show the export product to have an average value in Manila of 11½c. per lb. Therefore at the present time the annual gross return from an acre of land planted to abacá may be estimated at $115.

The probable cost of establishing an abacá plantation, including rental, clearing, cultivating, etc., and bringing to maturity, will be about $60 per acre, and the annual cost of subsequent care may be placed at one-tenth of this amount. Stripping is sometimes done on a share basis, but in any event the cost of harvesting, stripping and marketing the product should not exceed $50 per acre. Therefore the first full crop should eliminate the debit balance and in subsequent years the net return should be at least $50 per acre per annum.

The utilization of waste products will still further increase the revenue. It is believed that by the present methods of extracting the abacá fiber at least 25 per cent of it is wasted. For several years the Bureau of Science has been investigating the suitability of various materials for the making of paper pulp. Paper pulp manufactured from abacá waste was strong and of superior quality. It should be possible to utilize all of the abacá waste commercially for the manufacture of paper and such utilization should be a great benefit not only to the planters but also to the paper manufacturers.

The cultivation of abacá in the Philippines unquestionably is a most profitable branch of tropical agriculture and the opportunities for its extension are very promising. Prices seem to be fairly assured for some time to come and the planter who selects good land and modern methods of cultivation, fiber extraction and management should produce superior fiber at a minimum cost and have a handsome income assured.

Present Condition of Graphite Production in Madagascar

The French Ministry of the Colonies has just furnished the office of the Commercial Attaché at Paris information on the present production of graphite in Madagascar.

It is stated business conditions were so unfavorable during 1920 that no new producing districts were opened, no new company for the exploitation of graphite formed, and operations at a number of the old deposits ceased. This is explained by the fact that adverse conditions have recently necessitated selling graphite at a loss. Resumption of operations at the old beds is dependent only upon more favorable conditions, and new deposits will doubtless be discovered as soon as there is some incentive to greater production.

Previous decline in business is shown by the following figures covering exportation in metric tons (metric ton = 2,204 lb.) of graphite from Madagascar: 1917, 27,838; 1918, 15,015; 1919, 4,056.

Nitrogen and Case-Hardening

By Henry Fay

THAT nitrogen plays a more important rôle in steel than is generally supposed is evidenced by the increasing number of articles appearing in the journals on this subject; that it plays an important rôle in case-hardening operations is shown in the work of Brophy and Leiter which appeared in the Sept. 22, 1920, number of this journal and from some work which has been in progress in this laboratory during the past several years. This work is not in a state of completion and it is the purpose of this note merely to mention a few of the more important results already obtained.

The writer has long had a suspicion that the case-hardening produced by cyanide was partly a nitrogenizing process, and this was confirmed qualitatively about four years ago. The methods of analysis for nitrogen were so crude that it was thought desirable first to investigate the methods that had already been used for this determination. Dr. Frederick Hurum has investigated the various methods and he has demonstrated that the method of Grabe and Petrén, with modifications as to apparatus, is the most trustworthy. Very accurate results can be obtained by this method. Whether or not the method is capable of determining all of the nitrogen is still an open question which is now under investigation, but it is quite certain that it is capable of giving all of the nitride nitrogen.

As an example of the nitrogenizing process which takes place when a steel is heated in cyanide, I shall quote the following results from Dr. Hurum's thesis. A round bar of low-carbon steel was heated in a cyanide bath for ten minutes at 830 deg. C. and allowed to cool in the air. Successive layers $\frac{1}{200}$ inch in thickness were turned from this bar and analyzed for carbon and nitrogen, with the following results:

Thickness of concentric layers in succession from outside toward interior, in.....	1 $\frac{1}{200}$	2 $\frac{1}{200}$	3 $\frac{1}{200}$	4 $\frac{1}{200}$
Carbon, per cent.....	0.16	0.30	0.06	0.15
Nitrogen, per cent.....	0.57	0.201	0.155	0.027

It will be seen that the outside layer contains 0.57 per cent of nitrogen, which is indeed surprising when it is considered that this sample was treated for only ten minutes. The nitrogen progressively diminishes toward the center of the bar, but apparently penetrates at a slightly greater rate than carbon.

C. B. Sawyer in another thesis has made an experiment along the same line designed to compare the observed increase in weight of thin sheet iron when heated in cyanide with the increase of weight as calculated from the results of an analysis for carbon and nitrogen. The original analysis of the sheet iron showed 0.05 per cent carbon and 0.005 per cent nitrogen. Four pieces of this sheet iron, about 5 g. each, were cleaned, dried and weighed, then heated in sodium cyanide at 830 deg. C. for two hours, quenched in water, then washed, dried and weighed. The average increase in weight was 2.42 per cent. The analysis of a mixed sample from the four pieces shows 1.63 per cent carbon and 0.726 per cent nitrogen. The percentage increase in weight accounted for by the carbon-nitrogen analysis amounts to 97.6 per cent. This result seems to show conclusively that the reaction is essentially a carbonizing and nitrogenizing process.

Other processes for case-hardening than the cyanide method are also capable of introducing nitrogen into steel. A low-carbon nickel steel was case-hardened by Dr. Hurum in one of the best commercial bone-charcoal mixtures and from this bar successive layers were turned off and analyzed for carbon and nitrogen with the following results:

Thickness of successive layers, in.	1 $\frac{3}{100}$	2 $\frac{1}{100}$	3 $\frac{1}{100}$	4 $\frac{1}{100}$	5 $\frac{1}{100}$
Carbon, per cent.	0.61	0.48	0.22	0.19	0.14
Nitrogen, per cent.	0.031	0.025	0.019	0.0106	0.0037

The source of the nitrogen in this case is undoubtedly the ammonia from the raw bone, but the nitrogen in the air may also be involved to some extent.

Another striking illustration of the nitrogenizing process is shown in some specimens treated by Dr. Shimer's cyanamide process. The results obtained are the fololwing results:

Number	Time in Cyanamide Bath, Hours	Temperature, Deg. C.	Carbon, Per Cent	Nitrogen, Per Cent
0	Original	...	0.050	0.0049
1	2	650	0.440	0.505
2	2	750	1.082	0.579
3	2	800	0.835	0.187
4	1½	900	1.293	0.123

Several important facts are brought out by this experiment:

1. Diffusion of carbon takes place below Ac_1—viz., at 650 deg.
2. Nitrogen combines with iron and also diffuses below Ac_1.
3. The nitrogen content decreases with the rise of temperature, indicating that equilibrium is reached at some lower temperature.

In the experiment carried on at 800 deg. C. the carbon content and possibly also the nitrogen content is low due to the cyanamide bath becoming exhausted. Cyanamide has been replenished in the experiment at 900 deg. C. and the results at that temperature are accurate.

That the absorption of nitrogen in case-hardening operations is a general process seems to be fairly well established. Further evidence bearing on this point is shown by the fact that practically all successful case-hardening mediums are either highly nitrogenous, containing bone, leather, cyanides, ferrocyanides, etc., or are so designed as to be capable of absorbing atmospheric nitrogen. Such mediums as the latter always contain an alkali of some nature. Of course the methods involving the use of carbon monoxide or a hydrocarbon are exceptions to this statement.

In an article, "On the Conduct of Finely Divided Iron Toward Nitrogen," Remsen has shown that "when iron . . . and certain nitrogenous organic substances are heated together with metallic sodium in an atmosphere of nitrogen a cyanide is readily formed." Bucher has used this reaction, substituting sodium carbonate for metallic sodium, as the basis of his process for manufacturing sodium cyanide. This reaction is undoubtedly a general one whenever iron, an alkali and air, or nitrogen, are heated together. There is a formation of cyanide, and the cyanide in turn reacts with iron, forming carbide and nitride, which diffuse into the steel, the depth of penetration being dependent upon temperature and time. It is a well-known fact that iron in contact with pure wood charcoal is capable of being case-hardened only weakly, but if an alkali is added to this mixture the process is much accelerated, due undoubtedly to the formation of cyanide.

Ammonia reacts very readily with iron, forming nitride. Dr. Hurum has shown that the nitride is capable of being held in solid solution and that it acts in this respect similarly to carbon, forming an austenite. By microscopic means he has been able to show that a round bar when treated with ammonia under pressure will show on its outer surface an austenitic structure after quenching. At a short depth the structure is martensitic and further in is found free the familiar iron nitride. After turning off the outer layer the chips have been found to be non-magnetic and to have a much lowered Ar_1 temperature. The nitrogen concentration of the austenitic layer has not been definitely determined, but work is now in progress to this end. The formation of this nitride-austenite offers a probable explanation of the ease and rapidity with which steels are case-hardened in cyanide.

In view of the fact that steel combines so readily and with so much nitrogen, case-hardening can no longer be considered as merely a carbonizing process but must also be considered as a nitrogenizing process. The question of course will be raised as to whether the introduction of nitrogen is harmful. To this it may be answered that the evidence all points to its being beneficial, adding to strength and hardness, up to certain limits. As in the case of carbon, so with nitrogen, when increased beyond certain amounts new effects are produced. When it is definitely learned just how much nitrogen may be held in solid solution new light will be thrown on this subject.

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Prevention of Tarnishing of Polished Metals Under Heat-Treatment

In a process recently invented in Germany, for protecting polished metals which have to undergo annealing, from the tarnishing which occurs under ordinary treatment, a solution of boric oxide is used. The solution is only applied as a very thin film over the articles to be annealed, but it is claimed that it completely excludes atmospheric oxygen. The film melts at a temperature varying between 550 and 650 deg. C., according to its composition, and acts as a protection so long as it remains solid. Steel, for example, remains bright when heated to the melting point of the composition, and no coloration takes place when the steel is tempered. It is stated to be still more effective in the molten or semi-molten condition, as it then forms a perfectly gas-tight cover round the article, even when heated to the highest temperature used in practice. The coating is perfectly fireproof, does not evaporate and dissolves any oxidized matter on the surface of the heated metal. The coating can be applied either as a powder, sprinkled or dusted over the surface of the objects to be annealed, or as a liquid. It is soluble in water and methylated spirit, and the work to be annealed is simply dipped in the solution and allowed to dry. The coating peels off on cooling, or it may be dissolved in warm water.—*The Engineer*, Nov. 26, 1920.

Notes on Monel Metal

A Brief Statement of the Physical Properties of This Natural Alloy, and the Commercial Uses to Which It Has Been Adapted—Its Resistance to Corrosion and Its Strength at High Temperatures Are Perhaps the Most Useful Properties

BY PAUL D. MERICA
Superintendent of Research, International Nickel Co.

THIS alloy was introduced by the International Nickel Co. about 1905 and named after its then president, Ambrose Monell. It is a natural alloy produced directly from Canadian bessemer matte by roasting and reducing with charcoal and has the following average composition: nickel, 67 per cent; copper, 28 per cent; other metals (iron, manganese, silicon), 5 per cent.

Several grades of this metal are produced for different purposes of which the following typical analyses are given:

	C	Mn	Fe	Si	S
Rolled Monel metal sheet..	0.11	0.15	1.76	0.18	0.026
Rolled Monel metal rods...	0.26	1.78	2.00	0.20	0.035
Monel metal wire.....	0.12	1.66	2.10	0.13	0.025
Monel metal castings.....	0.18	0.25	1.90	1.06	0.03

It will be noted that the wire is made with low-carbon content in order that it may be readily cold-drawn, whereas hot-rolled rods are produced with somewhat more carbon in order to increase the ease of hot-rolling.

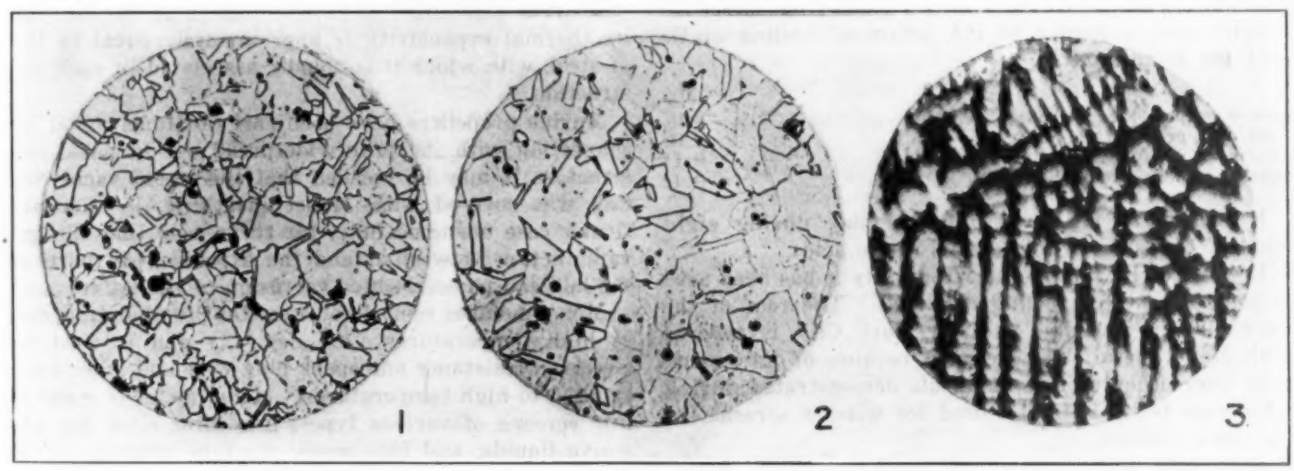
The practice in producing castings and malleable ingots of this alloy follows very closely that in the production of malleable nickel and nickel castings which has already been described.[1] After bringing to pitch in the furnace—i.e., adjusting the carbon and oxide content—it is deoxidized with manganese, or ferromanganese, and magnesium, the latter being used in the same proportions as for nickel, and poured into ingot molds or sand castings. Unless so deoxidized it is, generally speaking, not malleable and cannot be rolled or forged.

The ingots so produced may be rolled or forged at from 1,040 to 1,100 deg. C., using the same precautions as in the case of nickel against oxidation and absorption of sulphur during heating. Rods are produced by hot-rolling or forging; from these, bright, cold-drawn rods are also produced by close-annealing and cold-drawing. Wire is drawn from hot-rolled, close-annealed wire rod about $\frac{1}{4}$ to $\frac{3}{8}$ in. in diameter. Annealing of hot-rolled Monel metal preparatory to cold-rolling or drawing is carried out at about 900 deg. C., preferably in charcoal boxes to prevent scaling. Light scaling, however, may be removed by pickling with sulphuric acid and ferric sulphate as in the case of nickel, but it is a slow and rather unsatisfactory process.

Monel metal is on the market in the usual commercial forms, sheet, bars, wire and various special manufactured forms such as wire cloth, screens, nails, chain, bolts, nuts, golf club heads, and in the form also of castings.[2]

METALLOGRAPHY

The elements entering into the composition of Monel metal form a continuous series of solid solutions with each other, consequently the structure of the annealed or rolled metal is quite simple and similar to that of nickel, consisting of grains of solid solution with small particles of the oxides (?) of magnesium and manganese. This is illustrated in Fig. 1; the typical structure of cold-drawn rods is illustrated in Fig. 2. The structure of cast Monel metal is, however, quite different from that of cast nickel and is that characteristic of solid solutions—i.e., the cored or dendritic structure illustrated in Fig. 3. The darker portions are richer in copper than the light areas, due to the selec-



FIGS. 1 TO 3

Fig. 1. Rolled Monel metal rod. × 100

Fig. 2. Typical structure of cold-drawn Monel metal rod. × 150

Fig. 3. Dendritic structure of cast Monel metal. × 100

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[1] CHEM. & MET. ENG., vol. 24, p. 18.

[2] Booklets by the Monel Metal Products Co. and the International Nickel Co. describe the properties and uses of this alloy.

tive method of solidification. This heterogeneity of concentration is relieved by annealing and by the processes incident to hot forging or rolling.

Monel metal may be etched with satisfactory results by the use of the 50 per cent nitric acid solution containing 25 per cent of glacial acetic acid. It is also attacked by ferric chloride solutions, and such solutions are also suitable for metallographic etching; a solution containing 1 g. $FeCl_3$ to 2 c.c. concentrated HCl diluted to 2 or 3 volumes with water is recommended.

Monel metal exhibits the same phenomenon as does nickel of intercrystalline brittleness produced by exposure at rolling temperature to the action of oxidizing or sulphurizing gases.[3]

Uses and Applications

The principal properties of this metal which render it of commercial value are perhaps the following: Resistance to corrosion, the bright nickel finish which it takes and retains, its strength and hardness particularly at high temperatures, and its resistance to erosion by water and steam.

Monel metal resists excellently the action of ammonia, solutions of ammonium hydroxide, fused and dissolved caustic alkalis and carbonates, fatty and many other organic acids, sea water, solutions of neutral salts such as alum, sulphates, chlorides, etc., gasoline and mineral oils generally, phenol and cresols, photographic chemicals, urine, dry mercury, dyeing solutions, alcoholic and other beverages. It resists fairly well the action of sulphuric, weak phosphoric, hydrocyanic acids, hydrofluoric, acetic and citric acid, ferrous sulphate and dry chlorine. It is not resistant to the action of hydrochloric and nitric acids, molten lead and zinc, potassium cyanide fused or in solution, sulphurous acid, ferric chloride and chromic acid.

Monel metal sheet showed the following losses in weight upon exposure to the action of boiling acetic acid for eight hours:

	Mg.
Loss in wt. per sq.in. per hour in 10% acid	0.07
Loss in wt. per sq.in. per hour in 26% acid	0.08
Loss in wt. per sq.in. per hour in 56% acid	0.11
Loss in wt. per sq.in. per hour in 90% acid	0.12

It lost 0.078 mg. per sq.in. per day during eight months' exposure to cold glacial acetic acid.

Because of its relative incorrodibility it has been used to some extent for roofing materials. The roof of the Pennsylvania Terminal in New York City is covered with Monel metal sheet, selected because of its superiority over other roofing materials demonstrated during a ten-year test. It is also used for window screens for the same reasons.

Both rods and castings are used to a large extent in the manufacture of pumps, pump liners, rods, valves, etc., for handling sea water, mine waters and acid and alkaline corrosive solutions generally. One of the principal applications of the metal is in the construction of tanks and crates for pickling steel; rods are used for this purpose and have apparently proved superior to any other material. In this connection the results of corrosion tests of Monel metal rod in pickling acid are of interest. Rods exposed for ninety days to the action of continually renewed 6 deg. Bé. (6 to 7 per cent) sulphuric acid at 74 deg. C. lost weight at the average rate of 0.0045 g. per sq.in. per day, corresponding to the removal of a layer 0.00003 in. thick per day; the removal of a 0.1-in. layer would therefore require about ten years. In fact Monel metal pickle-pins and pickle-rods have been removed from service after eight years and were found to show practically no evidence of corrosion. Their average life is perhaps three years. On account of its resistance to corrosion the metal is also used in the construction of mining machinery, mine screens, dyeing machinery and equipment and in the chemical and oil industries for miscellaneous parts exposed to severely corrosive conditions.

Monel metal takes and retains a finish almost identical with that of pure nickel and is for this reason much used for small fittings, trimmings and stampings, for golf-club heads and for table cutlery. This property in conjunction with its resistance to corrosion by substances used in preparation of foods and in washing have made it valuable for the construction of certain cooking utensils and for washing tanks, cream separator machinery, etc.

The resistance of the alloy to steam erosion and its strength at high temperatures, which seems to be higher than that of the steels or bronzes, have caused its extensive application in the production of steam pressure valves and steam turbine blading. For these purposes it is well suited by further reason of the fact that its thermal expansivity is approximately equal to that of steel, with which it is usually associated in such construction.

Marine propellers have been cast of Monel metal. In connection with its quite widespread use in naval construction it may be recalled that the steam yacht Sea-Call was covered with Monel sheathing, in this particular case unsuccessfully, for the reason that the galvanic action between it and the exposed steel parts of the hull caused accelerated corrosion of the latter.

Monel metal is remarkably resistant to oxidation even at high temperatures (750 deg. C.) and is used for electrical resistance and spark-plug wire and other parts exposed to high temperatures. Monel metal is made up into screens of various types, into filter cloth for corrosive liquids, and into screw machine products of all kinds.

The physical properties of this alloy are described by the International Nickel Co.[3] Its melting point is about

[3] Chem. & Met. Eng., vol. 24, p. 198.

TABLE I. TENSILE PROPERTIES OF MONEL METAL

Material	Average Tensile Properties — Yield Point, Lb./Sq.In.	Tensile Strength, Lb./Sq.In.	Elongation in 2 In., per Cent	Average Range of Tensile Properties — Yield Point, Lb./Sq.In.	Tensile Strength, Lb./Sq.In.	Elongation in 2 In., per Cent	Reduction of Area, per Cent
Hot-rolled rods:							
Up to 1-in. in diameter	63,100	94,600	40				
1 1/8 to 1 1/2	62,000	93,000	39				
1 5/8 to 2 1/2	50,100	87,700	42	50 to 75,000	85 to 110,000	28 to 55	45 to 65
2 5/8 to 3 1/2	43,800	85,300	44				
Over 3 1/2	47,300	84,800	43				
Castings	37,100	72,300	34	32.5 to 44,000	65 to 85,000	25 to 45	.....
Annealed sheet	.....	.....	..	.....	60 to 75,000	30 to 40	.....
Cold-drawn rods	.....	.....	..	60 to 80,000	87 to 96,000	30 to 40	50 to 65
Wire { Annealed	.....	.....	..	.....	60 to 75,000	.....	.....
Wire { Hard drawn	.....	.....	..	.....	110 to 150,000	.....	.....

1,360 deg. C., its density in the rolled condition, 8.97 (0.323 lb. per cu.in.). The mean coefficient of thermal expansion between 20 and 100 deg. C. is 0.000015.

Its electrical resistivity in the form of wire is 42.5 microhm per cm. (256 ohm-mil per foot), temperature coefficient of resistivity 0.0019 per degree C. The thermal conductivity of Monel metal is one-fifteenth that of copper, or about $0.25 \frac{\text{watt-second}}{\text{cm.-second-deg. C.}}$.[4] The optical reflectivity of Monel metal is not markedly different from that of nickel; values are given in a previous article.[4]

Monel metal is slightly magnetic and its permeability varies markedly with composition and mechanical and heat-treatment. An annealed rod containing 66.1 per cent nickel, 28.8 per cent copper, 2.68 per cent iron, 1.91 per cent manganese, 0.22 per cent carbon and 0.29 per cent silicon gave the following values of magnetic induction:

Magnetizing Force-Gausses	Magnetic Induction-Gausses
1	413
2	699
4	989
10	1,203
20	1,244
50	1,282
75	1,300
100	1,317
150	1,346

With varying treatment, values of the magnetic induction for a magnetizing force of 50 gausses may be obtained varying from 500 to 2,000.

The modulus of elasticity (Young's modulus) is 22 to 23,000,000 lb. per sq.in.

Hardness varies with the form and condition of the metal, as may be seen from the following table:

	Scleroscope Hardness, Universal Hammer	Brinell Hardness 10-mm. Ball 500 Kg.	3,000 Kg.
Hot-rolled rods	20 to 30	100 to 130	145 to 170
Cold-drawn rods	.....	150 to 170	180 to 200
Cast Monel metal	20 to 25	90 to 100	.....
Monel metal sheet	.....	.....	.....
Annealed Monel metal	15 to 20	80 to 100	.....

The tensile properties of Monel metal also vary largely with the composition, conditions and size of the rod; values are given in Table I. The proportional limit of hot-rolled rods averages from 30,000 to 45,000 lb. per sq.in., that for castings from 15,000 to 25,000 lb. per sq.in.[5]

[4] CHEM. & MET. ENG., vol. 24, p. 75.

[5] Specifications are issued by the U. S. Navy Department for this alloy in its different forms and from which further information may be obtained of its tensile properties.

TABLE II. TENSILE PROPERTIES OF MONEL METAL AND 30 PER CENT NICKEL STEEL AT HIGHER TEMPERATURES

	Rolled Monel Metal				Rolled 30% Nickel Steel			
Temperature in Deg. C.	Tensile Strength, Lb./Sq. In.	Elastic Limit, Lb./Sq. In.	Elongation, per Cent in 2 In.	Reduction in Area	Tensile Strength, Lb./Sq. In.	Elastic Limit, Lb./Sq. In.	Elongation, per Cent in 2 In.	Reduction in Area
21	104,900	78,350	31.3	61.7	94,498	39,850	51.2	59.8
149	97,400	58,500	29.7	57.8	97,000	37,100	64.1	65.0
233	97,800	58,690	29.7	51.0	84,950	32,250	62.5	65.0
275	96,400	58,400	32.8	59.5	83,000	26,200	59.4	66.8
317	89,600	57,950	32.8	59.5	69,575	25,650	56.3	72.6
399	67,600	42,550	28.1	58.1	45,650	21,100	43.0	59.0
510	.....	.....	.....	.....	.....	.....	.....	.....
555	47,200	26,800	28.1	60.7	36,350	15,500	37.5	55.7

TABLE III. TORSIONAL PROPERTIES OF MONEL METAL AT HIGHER TEMPERATURES

Material	Temperature in Deg. C.	Torsional Strength	Elastic Limit	Twist	
	21	94,610	45,510	12 turns	150°
	196	83,030	33,940	5 turns	0°
	317	72,290	31,300	5 turns	205°
¾-in. rolled Monel metal	426	40,610	10,910	6 turns	240°
	19	91,990	37,780	11 turns	150°
	196	78,030	36,140	4 turns	320°
	...	54,210	19,800	4 turns	340°
	317	59,591	26,123	4 turns	90°
1¼-in. rolled Monel metal	426	38,600	10,680	7 turns	50°

The torsional properties of Monel metal hot-rolled rods have the following range of values:

Shearing stress at outermost fiber at proportional limit, 20,000 to 40,000 lb. per sq.in.; yield point, 50,000 to 80,000 lb. per sq.in.; maximum, 75,000 to 95,000 lb. per sq.in.

Direct shearing tests on hot-rolled Monel metal rods carried out in the engineering laboratory of Lehigh University gave the following average results:

Diameter of Test-Bar, In.	Single Shear Max. Stress, Lb./Sq.In.	Double Shear Max. Stress, Lb./Sq.In.
1	55 to 61,000	115 to 127,000
¾	45 to 50,000	90 to 103,000

Compression tests of rods and castings give the following results:

	Rods, Lb./Sq.In.	Castings, Lb./Sq.In.
Proportional limit	25,000 to 50,000	15,000 to 25,000
Yield point	60,000 to 70,000	20,000 to 30,000

Very few tests have been made of the resistance of Monel metal to the action of alternating stresses, but the indications of a few tests are that the hot-rolled rods about 1 in. in diameter will withstand approximately 10,000,000 complete reversals of stress—i.e., from tension to compression—at 25,000 lb. per sq.in., maximum fiber stress, these tests having been made on a White-Souther machine.

The effect of temperature on the tensile and torsional properties of Monel metal has been studied by Bregowsky and Spring,[6] whose results are given in Tables II and III.

Arnott[7] gives the following values which are the average of eighteen tests:

Temp., Deg. C.	Tensile Strength, Lb./Sq.In.	Yield Point, Lb./Sq.In.	Elongation in 2 In., Per Cent	Reduction of Area, Per Cent
20	92,700	47,700	51	69
320	86,200	38,100	48	62
410	75,700	35,600	49.5	63
500	64,300	34,100	45	56
630	36,300	23,300	33	...
700	23,100	17,700	27	36
905	6,300	3,600	27	28

It is evident that Monel metal retains its strength to a remarkable extent at higher temperatures as compared with brasses, bronzes and steel.

Webster[8] has studied the effect of cold-rolling on the tensile properties of Monel metal and has given the following values:

Material	Tensile Strength, Lb. Sq.In.	Elongation in 4 In.	Reduction of Area
Normalized Monel	79,000	26	35
Same after 20% reduction	102,000	4	22
Same after 40% reduction	118,000	3	18
Same after 60% reduction	132,000	2	17

[6] *Proc.*, Int'l Asso. Testing Materials, 1912, Sec. 1, Paper VII.

[7] *J. Ind. Metal.*, vol. 23, p. 545 (1920).

[8] *Proc.*, Int'l Asso. Testing Materials, vol. 7, p. 6 (1912).

A preceding discussion on the effect of impurities on the properties of nickel[1] apply with almost equal force to Monel metal. Carbon, as in the case of nickel, hardens the metal and renders it easier to roll and forge hot, but more difficult to roll cold. The separation of graphite begins at a somewhat lower content of carbon than in the case of nickel, in the neighborhood of 0.35 per cent.

Although a long, tough chip is produced in the machining of this metal, it may readily be machined when proper conditions are observed. Tools are required of high-grade, high-speed steel and should be ground with large rake or lip and kept sharp. It may be machined either dry or with lubricant and a good average speed for general work is from 50 to 60 ft. per minute with a ¼-in. cut and ⅛-in. feed.

Monel metal may be soldered and brazed in the same manner as iron or steel. It may be acetylene-welded. The welded joint will, however, not be as strong as the original metal and will have little ductility. Ordinary Monel metal wire rod may be used as the welding rod. Acetylene welding of this metal as well as of nickel should be executed with a nearly neutral flame, as the metal is highly sensitive at these temperatures to the presence of oxygen. Welded Monel metal and nickel tubes are being manufactured by the oxy-acetylene process.

British Lubrication-Research Report

The British Department of Scientific and Industrial Research has just made public the final report of the lubricants and lubrication inquiry committee appointed by the advisory council in 1917 "to prepare a memorandum on the field for research, containing an analysis of the problems involved, together with a suggested scheme of research which would be likely to lead to valuable results." The work accomplished may be thus stated in brief:

(*a*) The compilation of a bibliography of the chemical, physical and engineering aspects of lubricants and lubrication.

(*b*) The compilation of abstracts of important papers contained in the bibliography, especially in relation to chemical aspects of the subject.

(*c*) Research work on certain fundamental problems on which knowledge was lacking.

(*d*) Tests and reports on certain matters brought to the committee's notice by the department.

(*e*) The preparation of bulletins on cutting lubricants and on solid lubricants.

The work instituted by the committee at the National Physical Laboratory and elsewhere covered.

Tests with Lanchester worm gear.
Effects of pressure on viscosity.
Determination of the physical constants of oily and non-oily liquids.
Further apparatus for testing the effect of pressure on viscosity in an actual bearing.
Deeley's oil-testing apparatus.
Cup-and-ball viscosity tester.
Test of lubricating oils for aircraft purposes.
Experiments on cavitation on oil films.
Experiments on the addition of gelatine to oil emulsions to prevent separation.
Tests on a sample of compounding medium for lubricating oils.
Trials of "Oildag" in aëro engines.
Determination of the frictional coefficient of a shaft bearing, using oil with and without "Oildag."
Proprietary article called "Tonicol."

[1] CHEM. & MET. ENG., vol. 24, p. 198.

As to the future the committee recommends that research be carried on under these headings:

1. To isolate and determine the nature of the hydrocarbons in mineral lubricating oils which especially promote the properties of viscosity and "oiliness."

2. To determining the classes of hydrocarbons desirable in lubricants required to work under high pressure and high temperatures, particularly as regards their relative stability under the conditions obtaining in internal combustion engines, steam engines and air compressors.

3. To study the causes and means of preventing the formation of carbonaceous deposits from lubricating oils under the conditions named in (2), with special reference to the nature of the hydrocarbons, sulphur compounds, and resinous constituents of such oils.

4. To study the causes of emulsification in circulating oiling and in splash systems, with special reference to (*a*) the influence of the sulphur compounds in mineral oils, and (*b*) the characteristics of oils with non-emulsifying properties.

5. To study the causes of oxidation in circulation oiling systems, also the causes of formation of oxidation products in bearings and on bright metal surfaces.

6. To determine the direction in which the processes of manufacture can be modified so as to lead to the production of lubricating oils of improved types.

Synthetic Lubricants to Meet Special Requirements

7. To discover new methods of analysis which will enable the chemist, when examining a lubricating oil in the laboratory, besides determining its viscosity, specific gravity, flash point, etc., to determine the constituents of the oil and with the help of the knowledge gained under (1) to (5) to measure its ability to reduce friction and to meet the conditions of speed, load, temperature, and atmosphere in which it is required to work. Much of this information can be ascertained today only by the costly method of trial.

8. To elaborate further methods of producing lubricants synthetically in order to meet special requirements. Dicresylcarbonate, for example, has been used as a lubricant. Reduced naphthenes, glycerides of naphthenic acids, and cinnamenes have been prepared and shown to have lubricating value. It might be found possible to produce lubricants whose rate of change of viscosity is less and whose freezing point is lower than is the case with existing lubricants.

9. To prepare in a pure state the esters met with in animal and vegetable lubricating oils and determine their relative lubricating values.

Addition of Free Fatty Acids to Mineral Oils

10. To investigate the claim that the free fatty acids present in commercial fixed oils are the active constituents which enable these oils to improve the lubricating value of mineral oils, and to investigate further whether the addition of such acids to mineral oils may, in certain circumstances, improve their lubricating value.

11. To investigate the colloidal nature of lubricating oils and its bearing upon lubricating problems.

12. To study the effect of ultra-violet light, sunlight and ozone upon lubricating oils.

13. To investigate the phenomena of dissimilar surfaces (oil and metal) in contact, especially in relation to the property of oiliness.

Conservation of Heat in Power and Heating Systems*

Discussion of 85 Per Cent Magnesia Insulation, Showing Low Depreciation Rate Under Wetting and Drying and High-Temperature Conditions—Chart for Determining the Economical Amount of Insulation—Amounts of Coal, Heat and Money Saved by Insulation

By EDWARD R. WEIDLEIN†

THERE are two distinct methods of conducting scientific research for industry. Each of them has its advantages and, generally speaking, both are followed in investigational practice. The first is the more obvious. It consists in taking problems which are quite familiar and attacking them with the powerful weapon which science has placed in the hands of its trained workers. This method is capable of very wide application and has afforded most valuable results.

The second method is not nearly so obviously useful, but the history of scientific discovery reveals that it is extremely powerful. It consists in beginning not with a definite problem, but with the systematic application of the different branches of science to the study of a material of economic value, for the purpose of gaining as complete knowledge as possible of the nature and properties of the material. At first sight this procedure may appear to business men to be very indirect, but the experience of some of our most enterprising industrialists and associations of manufacturers shows that in the long run it is more profitable than the obvious and direct method.

If it is conceded that the indirect method of approach is often the better, it must be borne in mind that it is usually the slower. This has been the case in the Mellon Institute's elaborate study of the characteristics of "85 per cent magnesia" as a non-heat-conducting covering for power and heating systems.

The industrial applications of insulating materials may be divided into three main classes—viz.: (1) Boiler plants, steam pipes, and heated surfaces of all descriptions; (2) refrigeration plants and cold storage; and (3) furnace settings. This paper will be confined to a consideration of the conditions encountered in the first-mentioned class, for all the data which have been obtained so far relate to the conservation of heat losses from pipes and boilers.[1]

Fuel Economy Imperative

Heat insulation in all its varied aspects has a great future, since it is of recognized value in reducing working expenses, and specifically it is of very material aid in effecting fuel economy. It is recognized generally that the losses from bare pipes and boilers are considerable, but the real magnitude of these losses is little appreciated. The fact that the loss from 1,000 sq.ft. of exposed surface at 100 lb. per sq.in. steam pressure represents over 300 tons of coal annually is a sufficient justification for the serious consideration of the subject.

The need for economy is becoming more imperative since the prospect for low-priced fuel in the immediate future does not seem to be very encouraging. Accordingly, there have been introduced improved methods of combustion, resulting in the operation of boilers at higher steam pressures and a general advance in boiler-room efficiency. However, the improved steam production is nullified to a large extent unless improvements are also made in the steam conveyances. Higher boiler pressures necessarily imply higher steam temperatures, and higher temperatures inevitably call for reconsideration of the whole question of insulation. The proper amount of non-heat-conducting material which should be applied to any heated surface will be that at which the cost of an increment of the covering will just balance the savings which will be accomplished by the increment.

Good Insulating Materials

A good heat-insulating material should have low heat conductivity; low specific heat, it being necessary that as little heat as possible should be absorbed by it; low specific gravity, in order to avoid the addition of undue weight and the introduction of undesirable strains in the piping systems; and sufficient mechanical strength to withstand vibration and accidental knocks. Moreover, it should be capable of withstanding the action of water and, preferably, also acids; it should be one which does not crack with alternate heating and cooling and with alternate wetting and drying; it should not disintegrate or decompose at the temperature to which it must be exposed; it must have no corrosive action on the surface to which it is applied; and it must be non-flammable.

Air is a poor conductor of heat. The transmission of heat through air is effected not in a considerable degree by conduction, as in the case of metals, but partly by radiation and largely by convection or by the currents set up by the difference in specific gravity of hot and cold air. This explains, therefore, why a good non-conductor of heat is generally found to be a porous material, or one which has entrapped pockets of air throughout its substance. For the highest insulating efficiency, it should have a uniformly honeycombed structure, and these pockets of air should be sufficiently small to prevent convection currents being set up in them.

The value of "85 per cent magnesia" as a non-heat-conducting material is increased greatly by the inter-

*Read before the American Institute of Chemical Engineers, New Orleans, Dec. 6, 1920.

†Associate Director of the Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.

[1]The data presented in this report represent part of the results obtained during the course of an investigation conducted for the Magnesia Association of America by the Mellon Institute of Industrial Research. The object of the investigation is to determine the true facts regarding the value of "85 per cent magnesia" as a heat-insulating material, and therefore the data are confined to this particular covering, and no effort has been made or will be made to furnish comparisons with other heat-insulating materials.

The researches carried out at the Institute under the supervision of the author have been conducted by the following industrial Fellows: G. F. Gray (1917), Glen D. Bagley (1918), M. S. Mason (1919), T. S. Taylor (1920) and R. H. Heilman (1917-1920), the present incumbent.

The author wishes to express here his appreciation of the accomplishments of these Fellows and his gratefulness to P. Nicholls, of the Franklin Manufacturing Co., Franklin, Pa., for his constantly helpful co-operation during the progress of the investigations.

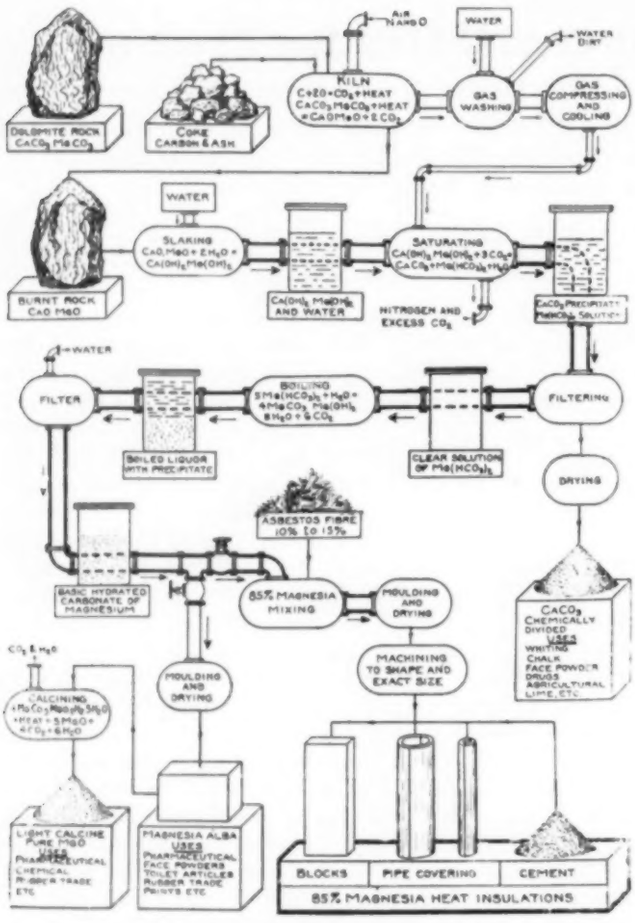

FIG. 1. FLOW SHEET SHOWING THE MANUFACTURE OF "85 PER CENT MAGNESIA"

lacing and felting together of the crystals to produce a block of magnesia containing 90 per cent of voids, which take the form of exceedingly small air pockets.

The name "85 per cent magnesia" denotes the fact that the coverings contain 85 per cent of basic magnesium carbonate, which is usually expressed by the following formula:

$$4MgCO_3.Mg(OH)_2.5H_2O$$

The remaining 15 per cent is asbestos, which is introduced as a binder to insure the requisite structural strength and durability. The flow sheet shown in Fig. 1 illustrates the method of manufacturing this product.

Pennsylvania dolomite rocks contain about 43 per cent of magnesium carbonate. The basic carbonate is separated in a pure form by a chemical process and is mixed with 10 to 15 per cent of asbestos fiber, after which the standard shapes and sizes are formed by a molding process. After the drying process, which requires five or six days, the rough-molded sections are planed to true dimensions. The heat insulation value is due largely to the mass of minute air cells formed by the interlocking walls of the crystals. This is also the reason for the extreme lightness of the product and for the ease with which it will absorb nearly three times its own weight of water. The Philip Carey Co., Cincinnati, Ohio; the Ehret Magnesia Manufacturing Co., Valley Forge, Pa.; the Franklin Manufacturing Co., Franklin, Pa., and the Keasbey & Mattison Co., Ambler, Pa., have supported this investigation through the Magnesia Association of America and they represent a total invested capital of $16,500,000, which indicates the magnitude of this branch of chemical industry.

In a study of the conservation of heat losses, the first important fact to be considered is the actual value of the losses from bare surfaces. It is often considered that the loss from any bare surface is 3 B.t.u. per sq.ft. per hour per deg. F. temperature difference between the surface and the surrounding air. While this value is correct for some special cases, it is by no means generally so.

Heat Losses From Bare and Covered Pipe

The full curves given in Fig. 2[2] show heat losses from bare pipes as predicted from Peclet's formula, and the dotted curve and points indicate the experimental results obtained by various investigators. The Peclet values agree closely with the experimental findings and can safely be used. They show that the constant may vary 50 per cent below 3 B.t.u. per sq.ft. per hour per deg. F. to values far above it. At 500 deg. temperature difference, which is often attained with superheated steam, the constant increases to double this value for the smallest size pipe. In some chemical plants steam is used at temperatures of 1,100 deg. F. The importance of using very thick insulation at these temperatures is easily judged from the rate at which the loss increases at 500 deg. F.

The next important point in a consideration of the conservation of heat is the value of the loss after the pipes are insulated. The electrical apparatus used in securing the experimental data is designed to test the material under conditions corresponding to actual practice. Tests have been made on five different makes of magnesia coverings in 1-in., 2-in. and 3-in. thicknesses. The results of the tests are given in Fig. 3. The contrast between the losses from a bare pipe and the losses through the various thicknesses of coverings is very striking. The efficiency increases with the temperature,

[2]See Bagley, *Trans.*, Am. Soc. Mech. Eng., vol. 40 (1918), pp. 667-94. Bagley presents detailed information regarding methods of tests and results.

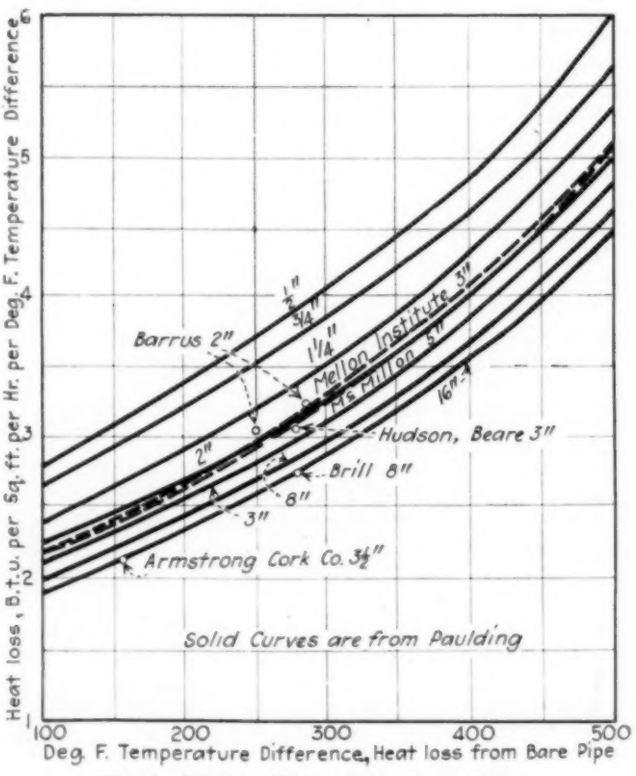

FIG. 2. HEAT LOSSES FROM BARE PIPE

for the loss from bare pipe increases much more rapidly in proportion than the loss from covered pipe.

Depreciation Rate Low

Pipe coverings may be subjected to wetting from leakage, floods, careless use of the hose, etc. Then, too, the necessity of removing and replacing the covering may arise. These questions, together with many others with regard to the permanency of the insulating qualities, rendered it necessary to conduct a careful investigation in this field, not only of new coverings but of coverings which had been in service for a number of years.

Tests were made to determine the effect of alternately wetting and drying coverings in relation to the change in heat conductivity, the change in mechanical structure and other physical chemical properties, and the possibility of removing and reapplying coverings which had been wetted.

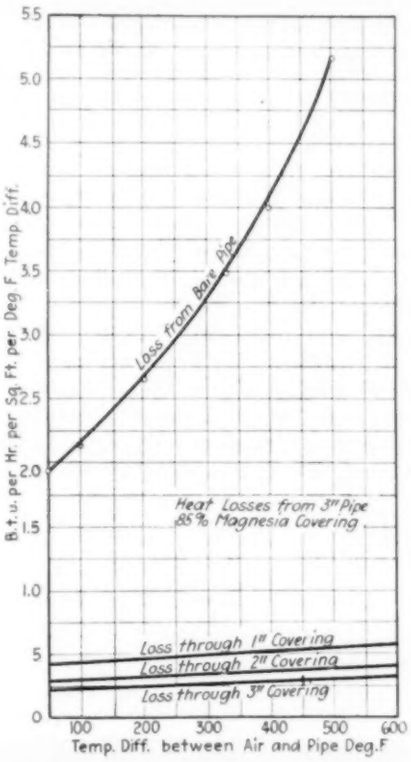
B.t.u. per Hr. per Sq. Ft. per Deg. F. Temp. Diff.
Loss from Bare Pipe
Heat Losses from 3" Pipe 85% Magnesia Covering
Loss through 1" Covering
Loss through 2" Covering
Loss through 3" Covering
Temp. Diff. between Air and Pipe Deg. F

FIG. 3. HEAT LOSSES THROUGH "85 PER CENT MAGNESIA" COVERINGS ON 3-IN. PIPE

The following routine test was made:

1. Inspect, photograph, weigh, measure and apply the sections of pipe covering.
2. Heat the covering forty-eight hours at a pipe temperature slightly above 212 deg. F.
3. Measure the heat conductivity of the covering up to 400 deg. F. (temperature difference from pipe to air).
4. Immerse the covering in water for thirty minutes, then dry the covering on the pipe at a temperature difference not exceeding 400 deg. F. Wet the covering four times, drying it after each wetting. Conduct the fourth drying at pipe temperatures of 212 and 250 deg. F.
5. Measure the heat conductivity up to 400 deg. F. temperature difference from pipe to air.
6. Observe and record the physical effects of the test upon each covering.

The magnesia coverings were successfully removed after each drying, then weighed, soaked, weighed again and reapplied four times. Fig. 4 is a photograph taken

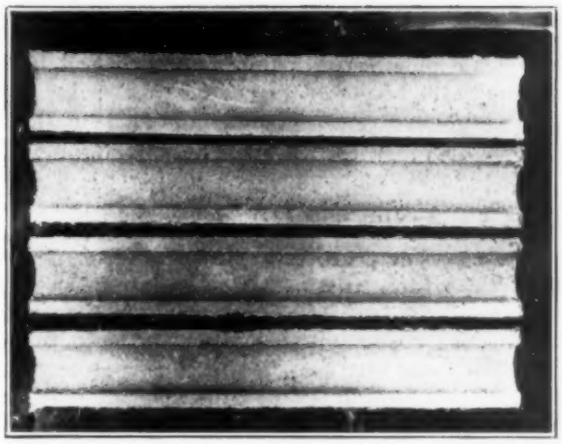

FIG. 4. CONDITION OF "85 PER CENT MAGNESIA" COVERING BEFORE (TOP) AND AFTER (BOTTOM) WETTING AND DRYING TESTS

of the covering before and after the wetting and drying tests. The heat conductivity is shown in Fig. 5 before and after wetting. The insulation value is increased, but in all cases the average shows the same conductivity before and after wetting and drying. The coverings were as strong after the test as before and could readily be reapplied, giving further evidence that they had not deteriorated; "85 per cent magnesia" has a crushing strength of about 100 lb. per cu.in., which is more than sufficient to withstand any of the ordinary strains or proper conditions under which it should be used.

Tests were made on several old magnesia coverings. Fig. 6 shows the conductivity of a 1-in. thick covering which had been in service for eight years at the Armour Glue Works in Chicago. The insulation value was slightly higher than the average of the new 1-in. coverings tested, showing that no deterioration in service had taken place. In the Niagara Power Station, in Buffalo, N. Y., "85 per cent magnesia" has been in service from sixteen to twenty years. A section and blocks were

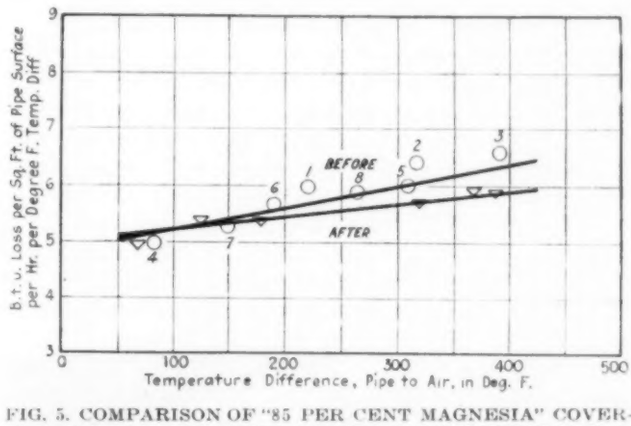

FIG. 5. COMPARISON OF "85 PER CENT MAGNESIA" COVERING BEFORE AND AFTER WETTING AND DRYING TESTS

tested and found to have increased in insulation value approximately 3 per cent. Several sections were obtained which had been saturated with oil. Tests on these showed much lower insulation values than new coverings. The damage was permanent and showed that care should be taken to protect coverings from oil while in service. Figs. 7 and 8 illustrate the conditions to which coverings are sometimes subjected and the value of having a good permanent covering.

Upon inspecting various installations of insulated

steam pipes, it has frequently been noted that the pipe has suffered considerable deterioration. This rusting of the steam pipe has in many cases been explained as being due to the action of the particular covering on the pipe, and not simply to oxidation on account of the pipe and coverings being frequently wetted.

The results of tests conducted in order to determine the probable influence of various factors on the rusting of insulated steam pipes indicate that the pipe coverings in general, especially if alkaline in composition, do not of themselves promote rusting on steam pipes when they become wet. In fact, they really act as a protecting coating, since the oxygen does not get into intimate contact with the surface of the pipe. However, an electric current flowing through the covering may either promote rusting of the pipe or it may retard corrosion, depending upon the direction in which it is flowing. When the current flows from the pipe to the outside of the covering, this causes the oxygen separated by electrolysis to be liberated at the pipe, thus promoting the

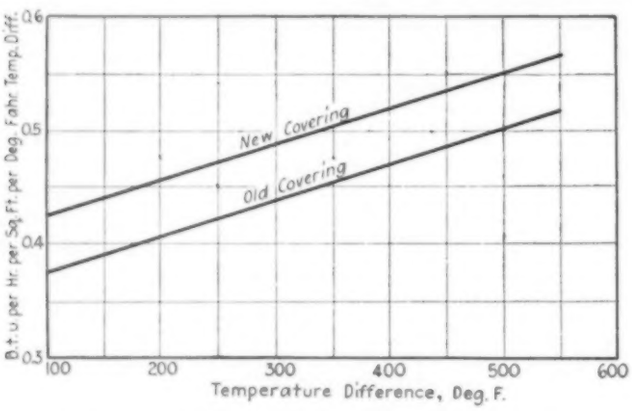

FIG. 6. COMPARISON BETWEEN OLD AND NEW COVERINGS

rusting of the pipe. The greater the current flowing the greater will be the rusting effect, so that if sufficient current were flowing a covered pipe might rust as much as the uncovered. When the current flows from the outside of the covering to the pipe, hydrogen formed by electrolysis is liberated on the pipe, which tends to retard any rusting of the pipe. The action of the electric current would be the same on an uncovered pipe, and the quantity of rust formed no doubt would be in the same proportion as was found in the cases of the exposed and covered pipes.

As the tendency in industry is to use higher temperatures, tests have just recently been completed at a temperature of 800 deg. F. The pipe was maintained

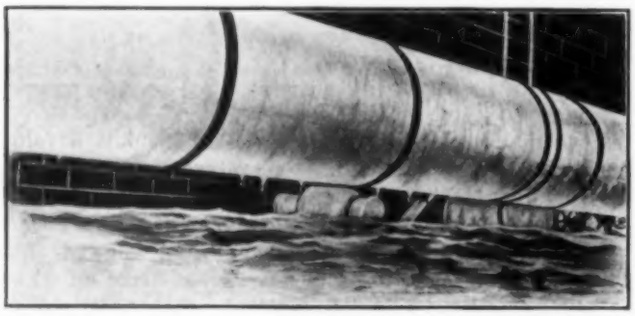

FIG. 7. THIS PIPE, COVERED WITH "85 PER CENT MAGNESIA," WAS SUBMERGED FOR THREE WEEKS BY FLOOD WATER WITHOUT DAMAGE

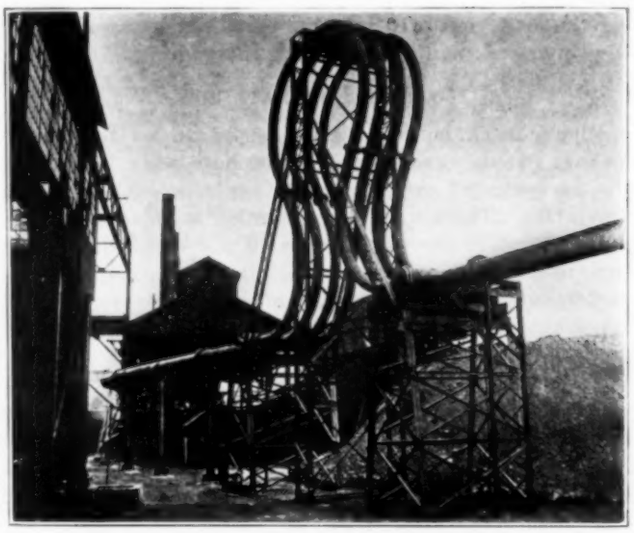

FIG. 8. EXPANSION JOINT IN 750-FT. 22-IN. PIPE LINE CARRYING STEAM AT 150 LB. "85 PER CENT MAGNESIA" COVERING ON THIS LINE SAVES 1,300 TONS OF COAL ANNUALLY

at a temperature of 800 deg. F. for a period of two months. The covering showed the average conductivity value, and after the test was not only successfully removed from the pipe but was in such a condition that it could have been successfully reapplied.

This agrees with the results obtained under actual working conditions in the plant of the Buffalo General Electric Co., Buffalo, N. Y. This company has in service 10-in., 6-in. and 3-in. steam lines which carry steam 75 per cent of the time at a temperature from 650 to 700 deg. F. with a peak temperature of 800 deg. F. The pipes have been covered with "85 per cent magnesia" for four years, and Fig. 9 shows a section of the covering removed from the 6-in. vertical steam line in perfect condition.

The Economical Amount of Insulation

A careful study of the technical and theoretical sides of any problem is essential in order to determine the economic value of the process or product, and so with

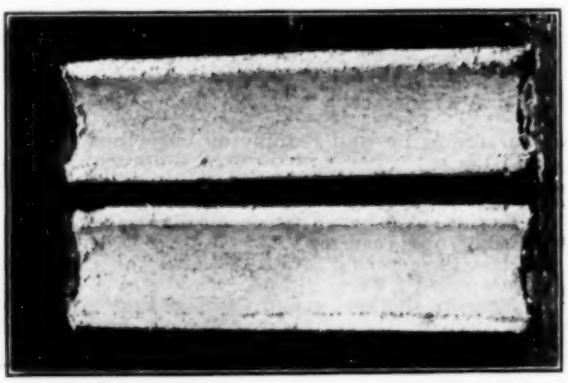

FIG. 9. SECTION IN USE FOUR YEARS AT TEMPERATURES FROM 650 TO 800 DEG. F.

"85 per cent magnesia" covering the result desired is the maximum net saving of money for any given condition. If the covering cost were nothing, the proper thickness would be limited only by the requirements of space available, for each increased thickness would result in some slight increased saving in heat. In a prac-

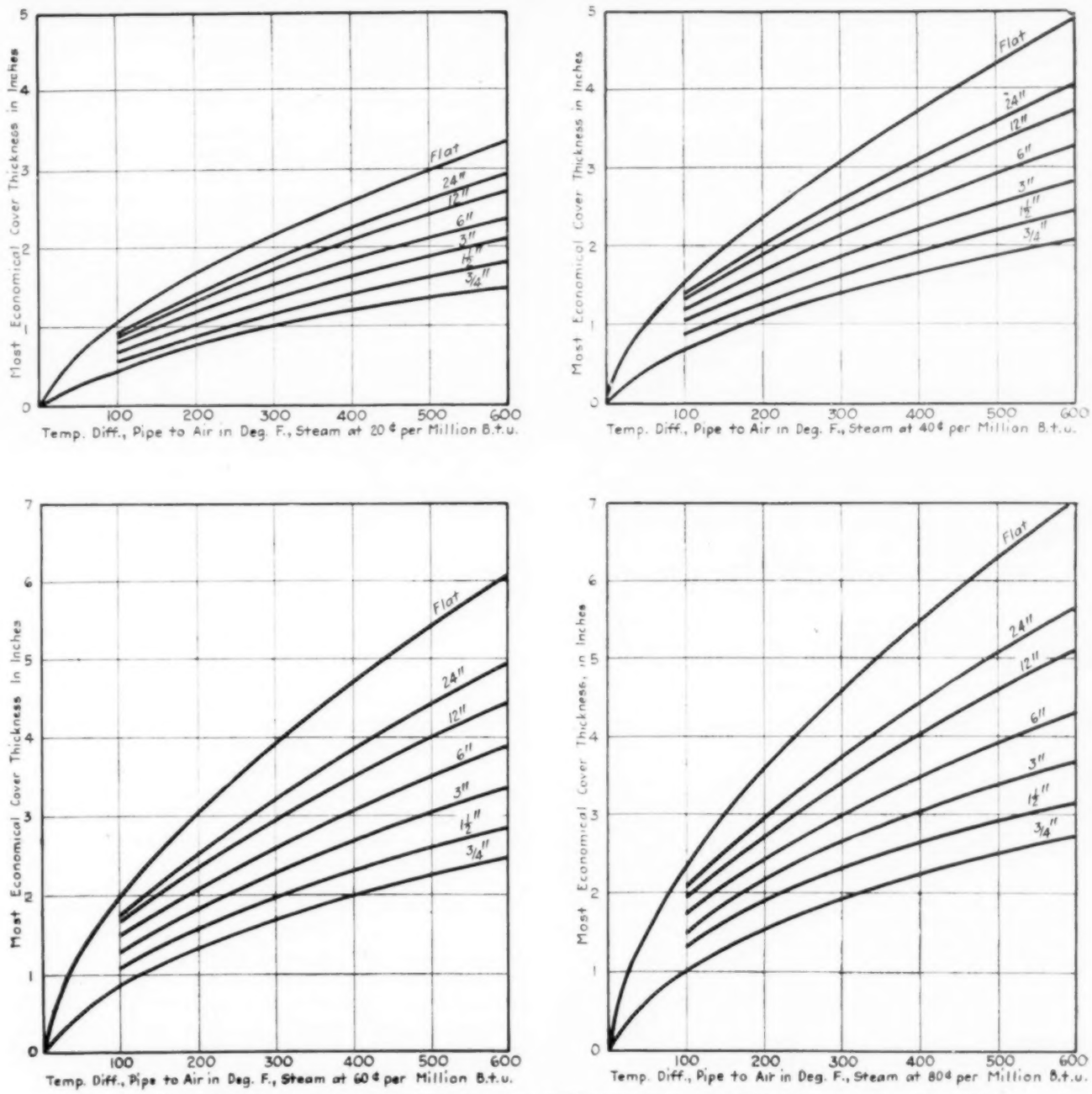
Most Economical Cover Thickness in Inches
Flat
24"
12"
6"
3"
1½"
¾"
Temp. Diff., Pipe to Air in Deg. F., Steam at 20¢ per Million B.t.u.
Temp. Diff., Pipe to Air in Deg. F., Steam at 40¢ per Million B.t.u.
Temp. Diff., Pipe to Air in Deg. F., Steam at 60¢ per Million B.t.u.
Temp. Diff., Pipe to Air in Deg. F., Steam at 80¢ per Million B.t.u.

FIG. 10. THICKNESS OF COVERING FOR MAXIMUM NET SAVING WITH STEAM AT 20c., 40c., 60c. AND 80c. PER MILLION B.T.U.

tical case where the covering has a definite cost, a point is reached where the increased cost of the covering will be greater than the additional saving in heat effected. It is this point in which the user of coverings is most interested, for it defines the maximum net saving to be accomplished.

One important factor to take into consideration is the fact that prices of coverings vary with the thickness. For flat surfaces the price is directly proportional to the thickness, starting at 30c. per sq.ft. for coverings 1 in. thick. The difficulties encountered in the manufacture of molded coverings for pipes result in an increased cost per sq.ft. for a 1-in. thickness, and the cost increases much more rapidly with the thickness than in the case of flat surfaces. More material is also required in molded coverings per sq.ft. of pipe surface than in the same thickness in flat blocks on account of the curvature of the surface.

The cost per sq.ft. of surface covered can be determined for any thickness desired. From this cost the annual fixed charges due to the covering can be calculated. After considerable investigation, it has been determined that 20 per cent of the list price of the covering would be a fair allowance for the cost of application, and 13 per cent of the total cost as the annual charges (6 per cent interest, 5 per cent depreciation and 2 per cent insurance and miscellaneous). This fixed charge has been calculated for seven different sizes of pipes and five different thicknesses, based on the manufacturers' list costs of coverings.

The other cost to be charged to the operating expenses of the covering is the value of the heat losses through the different thicknesses of coverings. The previous work done on measuring the loss through a large number of samples of magnesia furnished the necessary data for calculating the loss in heat units.

After the heat loss was determined, it was necessary to convert the loss into dollars and cents. The assumptions used in making this conversion were that 1 lb. of coal as burned will evaporate 7 lb. of water from and at 212 deg. F., and that each pound of steam contains 1,000 B.t.u. above the feed-water temperature. The value of the heat losses was calculated for seven sizes of pipes, five temperature differences between pipe and air, and four different costs of heat, both on the basis of a known cost per million B.t.u. and on a cost per ton of coal and the average conditions of steam generation given here. By making these calculations both ways, the results are applicable to plants where the steam costs are accurately known as well as to those where accurate records are not kept.

By combining the fixed costs and the heat losses per sq.ft. per year, the total operating expenses were obtained. Once these are known, it is simply a matter of selecting that thickness which gives the minimum annual operating expense to obtain the proper covering to use. It is evident that the thickness which gives the minimum operating expense also gives the maximum net saving, as the loss from bare pipe is a constant under given conditions and the net saving is the difference between the operating expense and the loss from bare pipe. The curves in Fig. 10 are for use in plants where heat costs, steam temperatures, etc., are accurately known. They are applicable to all heated surfaces, since they are based on the temperature of the surface and the value of the heat in dollars per million B.t.u.

Amounts of Coal, Heat and Money Saved by Installation

The savings accomplished by the use of the economic thickness of pipe covering is comparatively very great. The use of "85 per cent magnesia" of suitable thickness will result in a saving which will repay the original cost of the installation in less than a year in practically every case, and under constant operation at high temperatures where great thicknesses are called for the saving will often pay for the installation in as short a time as two months.

TABLE I. MONTHLY SAVING, IN DOLLARS AND CENTS, BY THE USE OF "85 PER CENT MAGNESIA" PIPE COVERING

Standard thickness, per 100 lineal feet of steam-pipe

Size of Pipe	5 Lb. Steam Pressure	10 Lb. Steam Pressure	50 Lb. Steam Pressure	100 Lb. Steam Pressure	150 Lb. Steam Pressure	200 Lb. Steam Pressure	200 Lb. Steam Pressure, 100° Superheat
...	$1.44	$1.58	$2.20	$3.28	$3.66	$4.11	$6.80
...	1.72	1.89	2.87	3.70	4.26	4.89	8.03
1	2.11	2.30	3.56	4.80	5.35	6.04	10.00
1¼	2.52	2.74	4.22	5.52	6.50	7.25	12.20
1½	2.86	3.10	4.73	6.14	7.29	8.17	13.70
2	3.53	3.74	5.86	7.63	8.93	10.11	16.80
2½	4.25	4.39	6.95	9.07	10.55	11.90	19.90
3	5.00	5.33	8.30	10.90	12.60	14.30	23.82
3½	5.72	6.22	9.60	12.40	14.40	16.32	27.23
4	6.50	7.06	10.60	14.05	16.40	18.40	30.85
4½	7.30	7.69	11.80	15.35	17.92	20.25	34.00
5	7.97	8.64	13.16	17.20	20.00	22.72	38.00
6	9.36	10.15	15.60	20.38	23.82	26.88	44.90
7	10.90	11.70	18.38	23.68	27.60	30.80	52.00
8	12.26	13.22	20.40	26.60	31.20	34.90	58.55
9	13.80	14.70	22.70	29.00	34.52	38.61	64.80
10	15.08	16.33	25.00	32.70	38.40	43.08	72.40
100 sq.ft. 1½-in. thick, flat surface,	5.26	5.67	8.80	11.50	13.48	15.12	25.44

Table I shows the actual cost saving per month with $5 coal by the use of "85 per cent magnesia" pipe covering. Table II shows in greater detail the serious losses which are going on in many plants today—losses which are wholly preventable but which amount in the aggregate to many tons of coal yearly.

Boiler Test Check on Losses

In order that the results of the laboratory test might be checked on a larger scale, several practical tests were made. The first and most important of these was a boiler test made at a mine in Bruceton, Pa. There were two boilers in the plant, of 80 and 60 hp., locomotive type. The total exposed surfaces on these boilers amounted to 675 sq.ft. The tests covered a period of twenty-four hours. Conditions of load, etc., were practically the same during both tests. During the first test, while the boilers were uncovered, 10,784 lb. of coal was burned to evaporate 58,000 lb. of water. In the second test, after the boilers had been covered with 2 in. of "85 per cent magnesia" blocks and plastic, 9,296 lb. of coal was burned to evaporate 59,500 lb. of water. The evaporation rate during the first test was 6.35 lb. of water from and at 212 deg. F. per lb. of coal as fired, and during the second 7.55 lb.; 1,500 lb. more water was evaporated with 1,488 lb. less of coal burned. If calculated for an equal evaporation of water, the saving in coal would be 1,700 lb. per day. The calculated saving based on the laboratory experiments was between 1,400 and 1,500 lb. per day. This saving amounts to 15 per cent of the coal burned due to covering the boiler alone, as the pipe lines were not included in the test.

TABLE II. COAL SAVED BY "85 PER CENT MAGNESIA" COVERING 1-IN. THICK

Steam Pressure	Saturated 5 Lb.	Saturated 10 Lb.	Saturated 50 Lb.	Saturated 100 Lb.	Saturated 150 Lb.	Saturated 200 Lb.	200 Lb. Pressure with 100 Deg. Superheat
Steam temp., deg. F.	228	240	298	338	366	388	488
B.t.u. loss per hr., sq.ft. bare pipe	367	409	625	802	937	1,058	1,735
B.t.u. loss per hr. sq.ft. of pipe covered with "85 per cent magnesia"	69	76	105	126	142	153	210
B.t.u. saved per sq.ft. by covering pipe with "85 per cent magnesia"	298	333	510	676	795	905	1,525
Tons (2,240 lb.) coal saved per 10,000 sq.ft. per yr. of 8,760 hr. by pipe covered with "85 per cent magnesia"	1,190	1,330	2,080	2,700	3,180	3,620	5,650
Cars of coal saved year, as above, at 40 tons per car	30	36	52	68	80	90	140

Necessity for Heat Insulation Likely to Be Overlooked

The matter of insulating against heat losses has received general attention in service power plants, large factory power plants and office buildings; but unfortunately, since it invariably receives final consideration in the construction of power and heating systems, it sometimes is regarded as a luxury—added only for the sake of appearance or neglected to save investment costs. The present tendency is to practice economy, and everyone realizes the importance of conserving the natural fuel supply, and yet the few finishing touches in the way of applying a good non-heat-conducting cover to protect such losses often are overlooked. It is one chemical product that will continue to work independently of the human element of control, and for many years to come will continue to effect economies figured in the cold business way of dollars and cents.

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Bluing and Browning Steel Articles

A Brief Description of Several Commercial Methods of Producing an Oxidized Finish on Polished Steel Objects, Including Analyses of Several Browning Solutions in Use in Various Establishments

By SIDNEY CORNELL

STEEL articles that have been polished and properly cleaned can be given a simple finish by immersing them in molten niter. This finish was specified for small components in rifles required by this and the allied governments during the late war. A mixture of half and half sodium and potassium nitrate is melted in a cast-iron or steel melting pot of shape and depth to suit the work. The pot should be clean prior to putting in the saltpeter, as rust from any source affects the color of the work. The niter is melted, superheated to a temperature of about 900 deg. F. (500 deg. C.) and black oxide of manganese added in the ratio of about 1 part oxide to 50 parts of niter, by volume. The manganese gives the molten salt a greenish-black tinge, and causes all suspended matter to settle to the bottom of the pot.

As bluing by this process forms an iron oxide film on the piece, consumption of the manganese oxide would be expected. Replacement at the rate of 1 lb. black oxide every three hours to a 300-lb. batch of saltpeter keeps the bath in condition. While it is doubtful what is the exact function of the manganese dioxide, this much has been observed: that if omitted from the pot the melt does not produce good work. Baths found upon analysis to be charged with iron oxide gave bad results, whereas no excess iron oxide was found in solution in any bath containing an excess of manganese oxide.

Operation of Niter Baths

In a niter bath a peacock blue or temper blue can be consistently obtained in the following manner: The articles to be blued are first cleaned, then given a thin coating of oil, then immersed in the hot niter at 600 to 650 deg. F. (315 to 345 deg. C.). The pieces may be either suspended individually on wires, or screws, nuts and other small articles may be dipped, inclosed in a wire basket. The parts are held in the niter for a few minutes, and then raised to note the depth of coloring attained, replacing in the molten salt until they reach the desired color. The time required varies with the temperature and with the size of the pieces but is never over four or five minutes.

The reaction is nothing more than obtaining a uniformly colored oxide film, as is obtained when tempering steel to color. If left in the niter too long, say ten minutes, the film produced is no longer a temper blue or a gunmetal blue, but has become a dirty gray. Preliminary cleaning in gasoline or similar solvent produces bad results, resulting in a mottled dirty surface. The oil carried on the surface of the parts takes fire immediately upon immersion in the hot niter, and if any moisture is present on the articles bad spattering of hot salt will occur.

After the right blue is obtained, the articles are quenched in cold, clean water to strike the color, then immersed in boiling water and finally in hot oil. Hot oil dip is very necessary in treating small screws or other tiny parts, as it removes from them all moisture, which if left on the blued article will form a spot of red oxide rust, a defect which has a tendency to form at the roots of threads or any re-entrant angle.

The lower bath temperature mentioned above yields the temper blue required by the French Government for finish of rifle parts, but the United States and the British Government require a darker gunmetal blue, to obtain which a temperature up to 1,000 deg. F. (540 deg. C.) is required.

Care should be taken not to dip articles after adding manganese oxide to a niter bath until the suspended oxide has sunk, as otherwise dirty spots will appear on a blued article. Cast iron, if highly polished, will take on a gunmetal blue corresponding to that given to polished steel, but it requires about twenty minutes' immersion at 1,000 deg. F. to accomplish this result.

Oil Blackening

Among other coloring methods for finished work may be mentioned oil blackening, which gives a dull finish; cyanide mottling, which gives a highly colored and mottled surface, and drawing to color in a sand bath, yielding a range of color from straw to purple.

To oil blacken, the polished steel part is packed in a carburizing box, using spent carburizing compound, and properly luted to exclude air. Box and contents are heated to 1,200 deg. F. (650 deg. C.), requiring about one and one-half hours. At 1,200 deg. F. the box may be drawn, the lid opened and the parts riddled free from carburizing compound and at once quenched in oil. A black oxide-skin is formed, dull in appearance but uniform in texture. It proved to be an ideal finish for front sights for rifles.

Cyanide Mottling

Cyanide mottling is obtained in a manner similar to oil blackening, except that an active carburizing compound may be used. To the spent mixture there is added approximately 5 per cent by weight of powdered potassium cyanide. Polished parts are packed in this material in a carburizing box, properly luted to exclude air, and heated to 1,200 deg. F. (650 deg. C.) for approximately four hours. Then the box is drawn, the articles are riddled free from compound and immediately quenched in oil. As air will quickly spoil the color effect, it is often advisable to quench direct from the box without riddling. If such colors as are obtained are too gaudy, the cyanide may be omitted, using pulverized charcoal in its stead.

Heat Tinting

A beautiful finish may be obtained by simply heating polished steel articles in a sand bath. Temperatures up

to approximately 650 deg. F., (340 deg. C.) should be used, but not higher, as high temperatures tend to produce gray colored work. The sand may be on a hot plate or, better, in a cylinder capable of being slowly rotated and heated by a gas flame underneath. From five to ten minutes will produce a fine rich blue when the sand is at approximately 650 deg. F.

PARKERIZING

Parkerizing[1] and other phosphatic coatings of iron and steel yield an excellent finish. In Coslettizing, the articles, polished and cleaned, are placed in a solution of ferrous phosphate, made from iron filings, phosphoric acid and water, and the solution boiled for approximately two hours. This treatment yields a coating to steel consisting of basic iron phosphate, which is strongly adhesive. Due to the low temperature used, the physical properties of tempered steel articles are not affected, even fine springs retaining their elasticity and magnets being unaffected. The method called Parkerizing differs from Coslett's original method by adding an oxidation agent and catalyzer to the solution, usually as MnO_2 to a 0.75 per cent solution of H_3PO_4, containing ferrous phosphate. The coating produced is then a basic ferroso-ferric phosphate, the ideal coating being one containing 3 of ferrous to 1 of ferric phosphate. After coating, the articles are gray in color, and after drying are usually coated with a paraffined oil to give them a deep black color. Considerable variation of color is possible by this treatment. When the articles are first placed in the bath a large quantity of hydrogen gas is liberated, and as soon as this ceases the process is complete. It is possible to treat a ton of parts at a cost not above $15 to $20.

BROWNING

There are many processes for browning steel, each of which is thought the best by its originator or user. The matter, however, may be summarized by describing one process, in spite of numerous variations, chiefly in the composition of the browning mixture. Other variations occur in manipulation and in the atmospheric conditions, artificial or natural. The longer browning processes have relatively low temperatures and humidities, while the shorter processes have relatively high temperatures and humidities. The longer processes have poor conditions, while the shorter processes have good conditions for rusting.

The operation of browning is conducted as follows:

First, applying the browning solution evenly over the surface of the article with a brush, a sponge or by dipping.

Second, keeping the article for a certain time in a room or cabinet where good conditions for rusting are maintained.

Third, boiling the article in water to reduce ferric oxide, Fe_2O_3, to the magnetic oxide, Fe_3O_4.

Fourth, carding the article to remove any loose particles of oxide on the surface.

The work, coated with the solution, should be placed in a warm room or cabinet, where a temperature of about 175 deg. F. can be maintained. Dry heat is satisfactory, as it is its function merely to bring the article up to a temperature such that when it is placed in the humidor rusting cabinet, dew will not form on the surface, causing spots in the color.

The rusting cabinet or room should be maintained at 175 deg. F. (80 deg. C.) and at any humidity up to the saturation point.

A third cabinet or room may also be used, although it is not absolutely necessary, conditioned the same as the first. Its object is to "set" the rust.

All of these rooms should have proper thermometers and thermostatic controls, and the rusting room a recording hygrometer. Temperature and moisture should be automatically controlled. The layout of the apparatus should permit of a proper flow of work from one process to the other.

PROCEDURES IN BROWNING

The procedures in browning are as follows:

The articles are first thoroughly cleaned, which may be accomplished by boiling for fifteen minutes in a soda solution. Any grease appearing on the surface of such a solution indicates need of soda ash addition. Then dry the parts by placing them on a draining rack. When cooled to approximately 120 deg. F. (50 deg. C.). coat with the browning solution. Dry for approximately thirty minutes, apply a second coat of the solution and dry for thirty minutes more.

The articles are then placed in the first warming room mentioned above, and brought to temperature, which may vary from 140 deg. F. up to as high as 175 deg. F. (60 to 80 deg. C.). With articles such as bayonets, thirty minutes in the warm room is sufficient. The time will naturally vary according to the size of the piece. Transfer them from the warm room to the rusting room. This must be at the same temperature as that of the warming room. Humidity up to the saturation point is desired, but danger of condensation should be avoided, as pitted and spotted work will result if the dew point is reached. Articles are rusted in approximately one hour and thirty minutes for such shapes as bayonets, others taking longer or shorter periods depending on the size and surface.

The rusted metal, now a dirty greenish red, is removed from the humid room to the third cabinet, if

[1] See CHEM. & MET. ENG., vol. 21, p. 787, Dec. 24, 1919.

TABLE I. COMPOSITION OF BROWNING SOLUTIONS

Solution:		A	B	C	D	E	F	G	H	I	J	K	L	M
Ferrous chloride	$FeCl_2$	....	....	....	....	....	....	....	....	....	0.9	....	....	....
Ferric chloride	Fe_2Cl_6	3.9	2.8	8.9	2.1	2.8	7.0	....	....	5.3	2.8	3.3	22.2	....
Mercuric chloride	$HgCl_2$	1.2	....	....	0.7	....	....	3.3	4.5	....	....	....	....	10.0
Cuprie chloride	$CuCl_2$	....	....	....	....	....	0.5	1.7	....	....	....	....	....	5.0
Antimony chloride	$SbCl_3$	....	....	....	....	....	....	....	....	....	....	....	22.2	....
Bismuth chloride	$BiCl_3$	....	....	....	....	....	....	1.7	....	....	....	....	....	5.0
Hydrochloric acid	HCl	....	....	....	....	....	7.5	9.9	....	....	....	....	....	30.0
Ferrous sulphate	$FeSO_4$	....	1.5	....	....	....	....	....	....	....	....	....	....	....
Cuprie sulphate	$CuSO_4$	0.6	....	....	0.7	1.5	....	....	....	1.8	....	2.5	....	....
Nitric acid	HNO_3	1.8	8.5	....	6.4	8.5	4.3	....	....	2.2	0.5	3.7	....	....
Spirits of niter	....	6.2	....	....	....	....	....	....	....	....	....	4.1	....	....
Ammonium chloride	NH_4Cl	....	....	....	....	....	....	....	4.5	....	....	....	....	....
Alcohol	C_2H_5OH	4.0	3.2	40.1	2.4	3.2	78.2	....	....	2.6	1.4	3.7	....	25.0
Gallic acid	$C_7H_6O_5$	....	....	....	....	....	....	....	....	....	....	....	11.1	....
Iron filings	Fe	....	....	....	....	....	2.5	....	....	....	....	....	....	....
Water	H_2O	82.3	84.0	51.0	87.7	84.0	....	83.4	91.0	88.1	94.4	82.7	44.5	25.0
Price per gallon		$0.90	$0.27	$1.45	$0.35	$0.30	$3.38	$0.86	....	....	....	....	....	....

used, and allowed to remain for thirty minutes. Then it is placed in boiling, clean water for fifteen minutes. The articles are allowed to drain dry, and then are carded on a wire brush or fiber wheel, which operation completes the first coating.

After the first coat, three more rustings are applied in substantially the same manner. Four coatings were required to make the finish required by the British Government, after which the browned surfaces are given a coating of thin white slushing oil.

Solutions for Browning

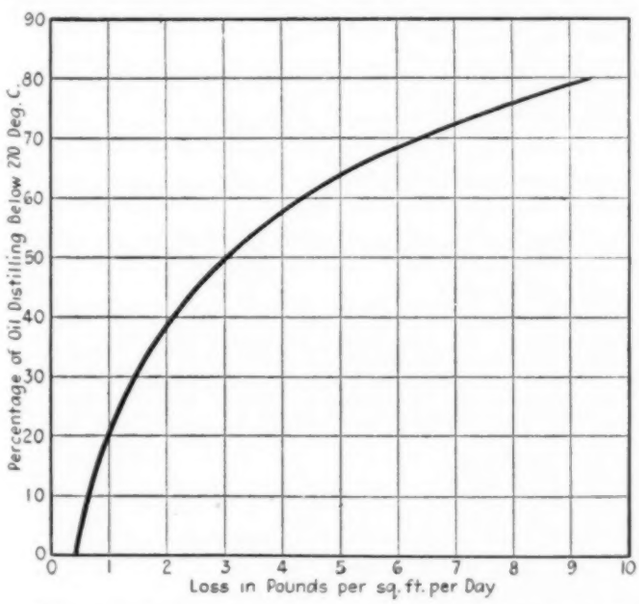
The number of solutions in use at various places total at least a score. Many formulas prescribe copperas or logwood for use in the water in which the articles are boiled after the rusting, but since omission of both of these ingredients led to the same finishes the conclusion was drawn that they were unnecessary. The complexity of browning solutions may be judged from the analyses in Table I and it might be stated that many of the ingredients appearing in them are as unnecessary as was the logwood or copperas in the wash water. Price and performance would be the guide as to the value of browning solutions, and they are arranged in their order of merit in the table.

Creosote Evaporation From Open Tanks*

The amount of creosote lost through evaporation in open-tank treatments is in proportion to the area of the exposed surface and the volatility of the oil. At the treating temperature of 195 deg. F., the loss of creosote in lb. per sq.ft. per day may be computed from the equation,

$$\log L = 0.0165\ V - 0.347$$

in which L is the loss in lb. per sq.ft. of exposed surface and V the percentage of the creosote distilling below 270 deg. C. Or the loss may be found without computation from the curve of this equation given below.



The equation and curve are applicable only when the temperature of the treating bath is in the neighborhood of 195 deg. F. At higher and lower temperatures, constants other than 0.0165 and 0.347 should be used, and these constants have not yet been determined.

*From *Technical Notes*, Forest Products Laboratory.

Legal Notes

By Wellington Gustin

Court Holds Langmuir's Patent for Incandescent Lamp Valid

Interesting facts of invention regarding the Langmuir patent 1,180,159 for the tungsten lamp are given in the recent case of General Electric Co. vs. Nitro Tungsten Lamp Co. in the U. S. Circuit Court of Appeals. The General Electric Co. is the assignee and owner of the Langmuir patent. Langmuir declares in his patent that it is not "new in the art" to use an incandescent lamp filament of tungsten, but that, though "it has been suggested in the past to introduce into a lamp bulb a neutral atmosphere at a fairly high pressure, I am not aware that any such lamps have ever been used commercially or have been technically successful." This success he sets forth in claim 4 of the patent, as follows:

"The combination of a lamp bulb, a filling therein of dry nitrogen at a pressure materially in excess of that corresponding to 50 mm. of mercury and a filament of tungsten of large effective diameter; the filament being thereby adapted for operation at a temperature higher than that which it would have if operated in a vacuum at an efficiency of one watt per candle."

Langmuir's lamp is known as the nitrogen lamp, in contradistinction to the vacuum lamp of an art about forty years old, and it was admitted that if the patent was valid the defendant was an infringer. So the trial court held defendant to account and the Court of Appeals has affirmed this.

The defendant contended that the "path of invention in respect of electric lighting has now been trodden by the feet of so many men of talent, and research even into its bypaths has been so thorough, that the first defense offered is that 'the teachings of the prior art are such as to leave no room for the exercise of patentable invention on the part of Dr. Langmuir'."

In addition to the art or knowledge of the practical man of skill in such lighting the court points out other phenomena known to the scientist. In any scheme of incandescent lighting, the energy supplied to the filament is subject to three forms of expenditure: it radiates in light waves; it escapes in heat, and is dissipated by the movement or "sweeping action" of whatever gaseous material may be in contact with the incandescent substance. The patent sets out these forms of loss as radiation, conduction and convection. The object of the vacuum was to do away with convection by dispensing with the gaseous surroundings. Raising the heat of the incandescent light giver produced more light, but the higher the heat the more rapid the deterioration of the incandescent filament. The reasons for this deterioration were obscure, says the court. The "air washing" of Edison had become an obsolete phase. But it appears that Dr. Langmuir was the first to establish, so far at least as tungsten is concerned, that to heighten heat hastened a true evaporation of the heated substance. Also introduction of an inert gas, usually nitrogen, into the lamp bulb delayed evaporation of the filament, but brought back and accentuated convection losses, which the vacuum had minimized.

When the rare and refractory metals, thorium and others, began to be hopefully regarded as possible supplanters of carbon filaments, it was suggested that if the lamp bulk be filled with a mixture of nitrogen and carburetted hydrogen the lamp would also have an excellent lighting capacity. But this was never reduced to practice. The court thought both the commercial and theoretic art had been put on a wrong road by Mr. Edison in his patent in 1883, and that before Langmuir no scientist had disclosed to the world that in the nitrogen-filled bulb the loss by convection would be diminished, and a working compromise reached between that loss and the gain in filament life, by increasing the "effective size" of the filament itself. Langmuir was also first to establish a crucial fact, that with a tungsten filament nitrogen of ordinary or commercial dryness was worse than useless.

The court found that Langmuir did not invent any nitrogen-filled bulb with any tungsten filament in it, but a special article of special proportions and a carefully stated co-ordination of parts.

Court Construes Contract of Seller Not to Engage in Similar Business

Restraint of a seller of a business from working in a similar business for a term of years was the proposition presented in the case of Cosmos Dyeing & Printing Works vs. Calderini and others, before the Court of Chancery of New Jersey.

It appears that under date of June 10, 1919, Delfiory Calderini and wife, doing business under the name Fiory Dyeing & Printing Co., entered into a written contract with complainant wherein the two Calderinis agreed to sell all the good will of the business of the Fiory Dyeing & Printing Co., at Haledon, Passaic County, N. J., together with all the machinery, etc., and also the land upon which the plant stood; also the processes and formulas for piece dyeing and finishing, secret or otherwise, relating to the said business. The consideration was $185,000. The defendants further agreed not to engage in the piece dyeing and finishing business in the State of New Jersey or in the State of New York for a period of five years from August, 1919.

In this suit the Cosmos company alleged that Calderini, in violation of his agreement, did engage in the silk dyeing and finishing business with the Atlas Fnishing Co., with works at Homestead, N. J., becoming its general manager. Defendant claimed that he was simply an employee at the Atlas works, and that his investment of $10,000 in such works was made for his son so that he might learn the trade and business. Facts developed that no salary had been paid Calderini prior to the hearing on this application for an injunction to restrain his working in violation of his agreement.

Upon argument for the application for an injunction it was agreed by the defendants that all money invested in the Atlas company by Calderini in behalf of his son would be withdrawn and that the only question remaining was as to whether he could go there and labor as a paid employee. The court taking proofs on the motion to modify the restraint on Calderini held the facts insufficient for granting a preliminary injunction restraining him from working for others as an employee, despite his covenant not to engage in such business in the states of New Jersey and New York for five years. It was said the Chancery Court should go as far as possible to restrain a fraudulent act by the seller of a business in violation of his covenant not to engage therein, but the restraint must be reasonable, and the words of the covenant carefully construed.

Moreover, the rule in New Jersey was held to be that where the complainant's right is uncertain as a matter of law, a preliminary injunction will be denied. The true intent and meaning of contract by the seller of a business not to engage therein is a question of law, particularly in view of its being one which may be in restraint of trade. The court was not willing to say on this preliminary application that the covenant prevented Calderini from working for the Atlas company. It said a preliminary injunction would not issue unless the injury sought to be prevented is irreparable.

Seller Not Responsible for Crop Failure Where Fertilizer Was Sold by Analysis

The Supreme Judicial Court of Maine has ruled that where fertilizer was sold under an agreement that it should contain certain percentages of designated ingredients, evidence that the buyer's crop failed on the land was inadmissible in an action for the price of the fertilizer, though such evidence would be admissible if the sale was accompanied by a guaranty of suitableness for the proposed crop. This ruling was made in an action brought by the Bowker Fertilizer Co. against B. H. Wallingford to recover the purchase price of fertilizer sold to and used by him. The fertilizer company had judgment and this was affirmed on the appeal.

It was admitted that samples of the fertilizer were taken at the factory from the same bins from which fertilizer was taken to be shipped to Wallingford, and were analyzed by the Maine Agricultural Experiment Station. The certificate of analysis showed 4-6-10, which was in accordance with the formula printed upon the bags and barrels received by Wallingford. The company had otherwise complied with state regulations. Wallingford defended failure to pay on the ground that the fertilizer was deficient in the elements necessary to aid him in the growing of a potato crop, and further damaging the crop.

In another case it was held that proof of defendant's own experience was too uncertain, speculative or conjectural to throw any real light upon the percentage of the ingredients of the fertilizer, and that such evidence is inadmissible when sold only on a guaranteed analysis basis. (Armour Fertilizer Works vs. Logan, 116 Maine, 33.) But it was held that such evidence is admissible when the sale was accompanied by guaranty of suitableness or results.

Now there is a rule of law that when anything is bought for a specific purpose there is an implied warranty that it is reasonably fit for that purpose. It was admitted that the fertilizer company's selling agent had knowledge that the fertilizer sold was to be used for raising potatoes; therefore, the buyer contended, the fertilizer as sold to him should have been reasonably suited for the purpose for which he bought it. But this contention was overruled by the Supreme Court.

It was said the sale was for a fertilizer of a 4-6-10 brand and nothing more. When fertilizer is sold under guaranty of analysis stated on its tag, there is no implied warranty of its suitableness for the growing of a particular crop, though the seller knew that the buyer intended to use it to fertilize land for such crop. This was said to be grounded in public policy, otherwise every crop failure might be made the basis of a suit.

Manufacture of Synthetic Ammonia at Oppau, Germany*—I

Principle of the Process—Manufacture of Producer Gas and Water Gas Used in the Process—Purification of the Gas Mixture—Catalytic Oxidation of Carbon Monoxide—Elimination of Carbon Dioxide and Carbon Monoxide

HABER'S researches enabled him to complete the work of Le Chatelier by determining the conditions under which the maximum combination of nitrogen and hydrogen in the presence of a catalyst to form ammonia could be obtained. However, before the process could enter into commercial competition, the following problems had to be solved: The economical production of large quantities of very pure hydrogen and nitrogen; extraction of the ammonia from the gaseous mixture; conversion of the ammonia into more readily marketable products; design and construction of suitable apparatus. A staff of chemists of the Badische Anilin- und Soda-Fabrik under the direction of Dr. Mittach worked on these problems for about ten years, and their results, combined with those obtained by others not directly connected with this company, led to the adoption of the commercial process now in use.

Principle of the Process

The principle of the process is as follows: Water gas, $CO + H_2$, is mixed with producer gas (lean gas), $CO + xN_2$, in convenient proportions; steam is added to this mixture and the whole is passed over a catalyzer at a temperature between 400 and 500 deg. C. The carbon monoxide and steam react and give hydrogen and carbon dioxide. The carbon dioxide is dissolved in the water at a pressure of 20 to 25 kg. and the remaining gaseous mixture is freed from harmful traces of carbon dioxide and carbon monoxide by passing it through solutions of caustic soda and ammoniacal copper formate.

The resulting gaseous mixture contains about 3 volumes of hydrogen per volume of nitrogen. The nitrogen content is kept systematically a little below this theoretical value and additional nitrogen obtained by the distillation of liquefied air brings the mixture to the exact proportions for ammonia. This mixture is then subjected, under a pressure of 200 kg. and at a temperature of about 500 deg. C., to the action of a second catalyzer, producing a little ammonia, which is immediately absorbed by water, and to the remaining gases which do not combine during this operation fresh amounts of gases are added and the whole is passed again through the catalyzer.

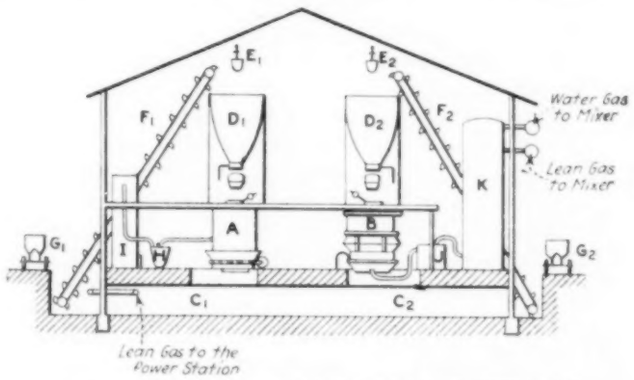


FIG. 1. SECTION OF PRODUCER-GAS BUILDING

The ammonia obtained by the distillation of the solution may then be oxidized by catalysis or combined with nitric acid thus formed to give ammonium nitrate, or used for the production of ammonium chloride by the Solvay process, or for the production of ammonium sulphate by reaction with gypsum in the presence of carbon dioxide. Finally, at the Oppau plant, starting with ammonium nitrate, diverse fertilizers are manufactured, such as ammonium-potassium nitrate and a mixture of ammonium nitrate and potassium chloride sold under the name of "Mischsalz."

Manufacture of Producer Gas and Water Gas Used in the Process

The lean gas is furnished by a battery of gas producers, the fuel used being lignite briquets from the Cologne district.

In addition to the gas used in the production of the nitrogen-hydrogen mixture, this battery supplies gas for use under the boilers and for admixture with coal gas to form "Kraftgas," which is used in internal-combustion engines.

The water gas is furnished by a battery of coke-gas generators. The coke used is of good quality, free from sulphur, coming partly from the Ruhr district and partly from the coke ovens at the works.

The battery of lean gas producers *A* (Fig. 1) consists of 23 units of the Berlin Anhaltische Maschinen Aktien Gesellschaft ("B.A.M.A.G.") type and that of the water-gas generators *B* consists of eighteen units of the Pintsch type. Both batteries are situated in the same building, 140 x 32 m. In each battery the gas producers are located in two rows parallel to the long sides of the building and at floor level. The ashes and clinkers are emptied into underground tunnels C_1 and C_2. Storage bins D_1 and D_2, 3 m. wide and 4.5 m. high, are placed over each row of gas producers. These bins are fed by the overhead cars E_1 and E_2, carried by aërial cables, or by bucket elevators F_1 and F_2. There are four bucket elevators at each side of the building, which take the fuel from the storage tunnels running along the outside walls of the building in which the fuel brought into the plant by the cars G_1 and G_2 is stored. Under normal condition the overhead cars are used for lignite fuel and the bucket elevators for coke.

Gas Producers

The gas producers ("B.A.M.A.G.") are of sheet iron lined with refractory brick and are 2.80 m. in diameter and 3 m. high. They are divided into three groups. Each group has a common hydraulic main *H* and a series of washing and purifying apparatus consisting of three

*From *La Technique Moderne*, November, 1920, pp. 449-460.

washing towers *I* 12 m. high and 1.5 m. in diameter and three rotating washers. Each of these washers is formed of two horizontal turbines 1 m. in diameter and 1.25 m. long direct connected to a 75-hp. electric motor. The two turbines are separated by a decantation vat in which the residue is collected. The gases leaving the second turbine pass through a cyclone tangential purifier with vertical axis by which the residue separates at the bottom, the gases leaving at the top through a 60-cm. diameter pipe. A bypass permits the escape of the gases to the atmosphere for a certain period when the gas producers are first started.

To facilitate supervision of the operation the gas producers are divided into groups of three units. These groups are connected to respective manipulating boards provided with six manometers indicating the pressures at the bottom (about 310 mm.) and on top (about 130 mm.) and with means to operate hydraulically the regulating valves.

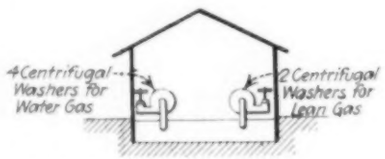


FIG. 2. SECTION OF TURBINE WASHERS BUILDING

The fuel consumption is 125 kg. per hour per sq.m. of grate. The entire installation consumes 440 tons per twenty-four hours, giving 1,235,000 cu.m. of gas and 10 tons of tar—that is, about 2.8 cu.m. gas per kg. of briquets. The calorific value of the gas is 950 cal. per cu.m. and its average composition is 30 per cent CO, 67 per cent N_2 and 3 per cent CO_2. The life of the refractory lining is about two years.

Water-Gas Generators

The water-gas generators are also of sheet iron lined with refractory brick. Two units constitute a group. Each group has a common manipulating board, two scrubbers *J*, a double main pipe and a washing tower *K*. The manipulating board is provided with six manometers giving the pressures at different points and with means to operate hydraulically the regulating valves.

The gas producers are operated in cycles of four minutes, thus: Air is blown in at the botom for one minute, the gases escaping through a chimney. Then superheated steam at 270 deg. C. and 12 kg. pressure is injected for half a minute at the bottom, then two and one-quarter minutes at the top, and finally for one-quarter minute at the bottom.

To stop the operation of the producers without extinguishing the fires it is sufficient to open portholes at the top, and the operation can be started again, even after a shutdown of twenty-four hours, by simply blowing in air for ten minutes.

The ashes and clinkers are crushed by rotating grates and dumped into underground galleries.

The fuel consumption is 100 kg. coke per hour per sq.m. of grate. The entire battery consumes 265 tons per twenty-four hours (14.75 tons per gas producer per twenty-four hours), giving 375,000 cu.m. of gas—that is, about 1.4 cu.m. gas per kg. of coke. The calorific value of the gas is 2,400 cal. per cu.m., and its average composition is 50 per cent H_2, 40 per cent CO, 4 to 6 per cent N_2, 6 to 4 per cent CO_2.

The air needed for the operation of the gas producers is carried in three conduits which are supplied respectively by one 2.5-m. diameter blower driven by a 600-hp. Brown-Boveri turbine, four 1.5-m. diameter blowers, each driven by a 140-hp. electric motor, and one 1.5-m. diameter blower driven by a 100-hp. electric motor.

Under normal conditions the total power absorbed for supplying the air is 700 hp. Special apparatus are provided for indicating at each instant the quantity of gas in the gas holders, for the automatic recording of CO_2 content in the gases and for the calorific power of the gases (Junkers calorimeters).

Purification of the Gas Mixture

The gas mixture to be catalyzed consists of 2 parts water gas and 1 part lean gas. There are three 15,000-cu.m. gas holders, one for lean gas and two for water gas.

From the gas holders the gases pass through 1.5-m. diameter turbine type washers (four for water gas and two for lean gas), which are placed in the same building (Fig. 2). Each of these turbines is driven by a 37.5-kva. electric motor. From the turbines the water gas is led tangentially into apparatus called cyclones in which the water and the particles in suspension are separated at the bottom and the gas leaves at the top and enters the main pipes. Similarly the lean gas is sent into the respective cyclones and thence to main pipes. By a set of regulating valves the gases may be returned to the turbines for further treatment.

The circulation of the gases is controlled by four manometers, of which two are marked respectively "water-gas inlet" and "water-gas outlet" and the other two to indicate the velocities. It is probable that the quantity of water gas supplied is quite constant and that all the regulating necessary is for the needed quantity of lean gas.

The gases after pasing three 10,000,000-cu.m. rotary meters (one for lean gas and two for water gas) are mixed and forced by three turbo-blowers to the catalysts for the reaction $CO + H_2O$.

Catalytic Oxidation of Carbon Monoxide

During the catalytic oxidation of carbon monoxide two points are of importance according to the patents of the Badische Anilin- und Soda-Fabrik—namely, the degree of porosity of the catalytic mass and the temperature regulation. The temperature has to be maintained at about 500 deg. C., because the reaction takes place only around this temperature and experience has shown that the catalytic power of the mass is destroyed at 600 to 650 deg. C.

A regulating device building is situated near the turbine building and is electrically connected to the catalyzer building. It is from this regulating device building that the supply of the gases to the catalyzer building is controlled. The devices consist of valves, recording indicators giving at each instant the velocity of the gases through the meters, recording indicators graduated in cu.m. giving probably the volumes of the gases in the holders and Winkler burettes for gas analyses. The different buildings through which carbon monoxide gas circulates are provided with CO indicators to give warning by sight and sound of the presence of this poisonous gas in the atmosphere of the buildings.

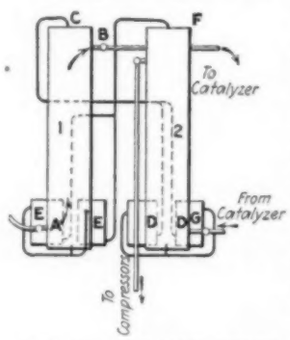


FIG. 3. ARRANGEMENT OF TOWERS

At the outlet from the turbo-ventilators the gaseous mixture receives the exhaust steam from the turbines (expanded from 12 to 4 kg.) in the proportion of about 76 g. steam per cu.m. of gas mixture (0.857 kg.), and the whole enters two 17-m. towers (Fig. 3), where it

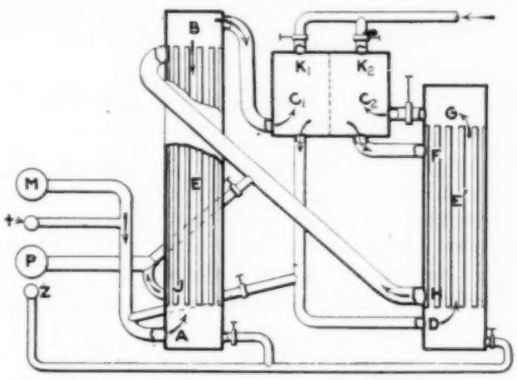


FIG. 4. SCHEMATIC ARRANGEMENT FOR THE CATALYSIS OF CARBON MONOXIDE

is heated and saturated with water vapor by jets of very hot water (about 95 deg. C.) This water comes from the washing of the catalyzed gases. The gases arriving at *A* in the first tower leave at *B* and are sent to the catalyzer. The warm water coming from the reservoirs *D* enters at *C* the reheating tower 1 and is collected in the reservoir *E*, whence it is brought to *F* and enters the tower 2 to cool the catalyzed gas which enters through *G*. The heated water is collected in *D* and the cycle can begin again.

After leaving the tower through *M* (Fig. 4) the gas receives an additional quantity of steam, and enters at *A* the heat exchanger *E* (1.5 m. in diameter and 7.5 m. high) and through *B* the first catalyzing chamber C_1; thence through *D* into the second heat exchanger *E'* (5 m. high), which is superposed on the first heat exchanger as shown in Fig. 5, thence through *G* into the

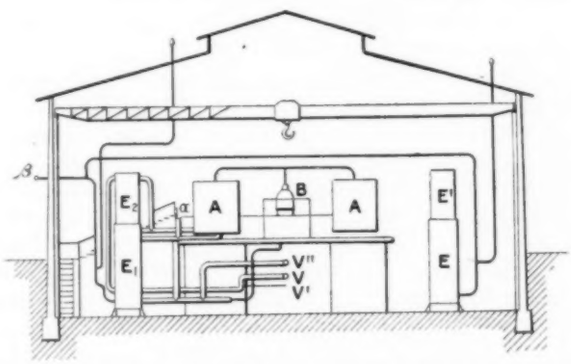


FIG. 5. SCHEMATIC ARRANGEMENT IN THE CARBON MONOXIDE CATALYZING BUILDING

second catalyzing chamber. From here the catalyzed gas passes the heat exchangers in an opposite direction following the path *FHIJ* and enters the washing tower 2 of Fig. 3 through *P*. Hot gases from a Perrot furnace enter the catalyzing chambers through K_1 and K_2 and serve to bring the temperature of the catalyzers and heat exchangers to that required for good operation and leave through *Z*, leading to a chimney.

The catalyzing chambers are prismatic, 3 x 6 x 5.5 m., and are separated by a tight partition. In each of these sections are sheet-iron containers with the catalyzer (a mixture of iron oxide, FeO, and chromium sesquioxide, Cr_2O_3) spread in five layers. There are twenty-four such containers placed in two rows of six in two buildings. (Fig. 5.) At the outside of these rows are placed the corresponding heat exchanger, one double heat exchanger per catalyzing unit. In each section of the catalyzing building there are six Perrot furnaces *B* placed between the two rows of catalyzers. These furnaces use "Kraftgas" (a mixture of lean gas and coal gas) as fuel, and the hot gases are used for reheating as previously described. The additional supply of nitrogen needed (see p. 305) is brought to the catalyzed mixture through pipes β.

The process requires the addition of about 1,167 tons of water to the gas mixture per twenty-four hours.

The gases leaving the first catalyzing chamber analyze about 28 per cent CO_2 and 2.2 to 3.4 per cent CO; in the gases leaving the second catalyzing chamber the CO content is only from 1 to 1.6 per cent.

The temperature of the catalyzers does not exceed 500 deg. C.

The operation is controlled by:

Sixty thermocouples per catalyzer grouped in three series of twenty, each wired to a switchboard with a

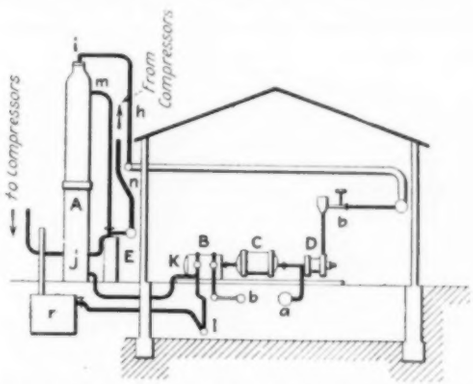


FIG. 6. SCHEMATIC ARRANGEMENT FOR THE ELIMINATION OF CARBON DIOXIDE

single galvanometer. This galvanometer can be connected to any one of the thermocouples.

Three mercury manometers connected to Pitot tubes placed at the outlet of each catalyzing chamber and on the steam pipes.

Six electrically driven pumps for circulating the water, of which three 45-kw. are for tower 1 and three 40-kw. for tower 2. (Fig. 3.)

Elimination of Carbon Dioxide, Compression and Purification

The catalyzed gas is collected in a gas holder, whence it is taken to be compressed. The compression takes place in five stages—namely to 5, 9, 27, 80 and 200 kg. When the gas is at 27 kg. pressure it is washed with water at the same pressure to remove the carbon dioxide. There are twelve compressors, of which six are of the Sulzer type and six of the Schwartzkopf type. Each one of them is driven by a two-cylinder-in-tandem gas motor 800 mm. internal diameter and 2-m. stroke. The total power required to drive the twelve pumps is 12,600 hp.

The gas, compressed to 27 kg., enters at *j* the absorption towers *A* (Fig. 6), which are provided with Raschig rings. The dimensions of these towers are 1.2 m. diameter x 12 m. high. Six centrifugal pumps *D* of the Sulzer type driven by 180-kw. motors circulate the necessary water, which enters the top of the towers

A at *i*. The gas, which leaves the towers at *m*, is led to purifiers *E* and through the pipings *n* back to the compressors. The wash water is sent through pipings *K* to a Pelton turbine *B* direct-connected to the electric motor *C*. The expansion of the compressed water takes place in this turbine and 60 per cent of the original energy required to compress it is thus recuperated. From this turbine the water falls into a reservoir where the CO_2 is separated and sent to a gas holder through pipings *b* and the water thus freed returned through pipings *l* to the water compressors.

There are twelve absorption towers and twelve separators, divided into six groups, each group having its own pump.

The operation is controlled by:

A velocity indicator for the inlet gases.

An indicator giving the volume of the gas taken from the gas holder.

Indicators showing the presence of carbon monoxide in the atmosphere of the building.

About 3,200 cu.m. of water is required per hour. The energy spent to compress the water is about 0.4 hp. per cu.m., when the amount of energy recuperated in the Pelton turbine is taken into consideration.

At the outlet from the towers the CO_2 content of the gas is not more than 0.8 per cent.

Elimination of Carbon Monoxide

A series of tests were made to eliminate the carbon monoxide by the use of an appropriate absorber. After many trials with various absorbers the Badische Anilin- und Soda-Fabrik has adopted an ammoniacal solution of copper formate for the absorption of CO.

The gas, compressed to 200 kg., enters the absorption

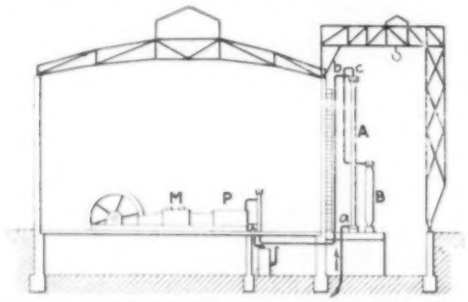


FIG. 7. SCHEMATIC ARRANGEMENT OF INSTALLATIONS FOR THE ELIMINATION OF RESIDUAL CARBON MONOXIDE

towers *A* (Fig. 7) at the bottom at *a*. There are fifteen towers working in parallel. They are provided with Raschig rings. The ammoniacal solution, compressed to 200 kg. by twelve piston pumps *P* driven by steam engines *M*, is sent to the towers *A* through *b*. The gas leaves the towers at *c*, enters the separators *B*, where the liquid in suspension is separated, and then to towers with soda lye, where the remainder of CO_2 is removed. The circulation of the soda lye at a pressure of 200 kg. is made by two pumps analogous to pumps *P*.

After expansion the cuprous solution is sent to a regenerating plant, where it is submitted to the action of heat and vacuum.

The hourly consumption of ammoniacal solution is about 40 cu.m., which can absorb about 720 cu.m. of carbon monoxide. The daily consumption of formate is about 320 kg. The hourly consumption of soda lye is about 8 cu.m.

The twelve circulating pumps are on the ground floor of a 75 x 20-m. building. The towers and the separators are located along one of the long sides of the building. The towers are forged steel tubes 12 m. long, 80 cm. outside diameter and 12 cm. thick. Each tower is provided with a level indicator showing when it should be disconnected for the removal of the lye.

(Part II will be published in a subsequent issue.)

Gutta Gaekwar, a New Base for Chewing Gum

By Frederic Dannerth, Ph.D.

Some time ago our attention was called to a new material which, it would seem, will become of considerable importance in developing products in the industry of plastics. The material is known commercially as gutta gaekwar, and we are advised that it is the coagulated milk juice of latex-bearing trees in Borneo. The product has been refined to a certain extent, so that it appears with the consistency of hard cheese, and it can be cut in slices with a knife. The gutta has a cream white color, but so far as our examination has gone it appears to be a straight natural product, not mixed with other guttas or milk juices.

It is almost tasteless when chewed, has a slightly sweet odor and has about 15 lb. of water in 100 lb. of the material as imported. The resin content of the actual gutta, after the water has been removed, averages 65 to 66 per cent. These resins have a melting point of about 160 deg. C. They have many peculiar and interesting physical properties, of which one is of particular importance—they contain more than 50 per cent unsaponifiable matter, and the unsaponifiables bear a close resemblance to the unsaponifiable matter found in wool grease.

When the original gutta is heated in the oven to a temperature of 100 deg. C. it becomes very tacky, and it is easy to draw "strings" when stirring the mass. From this we conclude that the material will be of interest in cases where a strong "binder" is needed for plastic masses. The material sent to this laboratory was in the form of a brick weighing about 5 lb., but after resting in the dry air of the storage room for a few weeks it lost a large part of its water. The dry material has, however, not lost any of its valuable properties. It may be rendered plastic by heating in a double-jacketed kettle or in an oven. In this condition it may be mixed with powdered minerals such as whiting or iron oxide, or it may be mixed with powdered sugar or powdered starch. Thus it has been possible to produce compact masses which can be formed into a variety of shapes.

The special uses for which gutta gaekwar seems adapted are:

1. As a binder in place of shellac, in preparing plastic masses.
2. As a base for chewing gums (to be mixed with softeners and sugar).
3. As a substitute for chicle (by adding waxes to the gutta).
4. As an organic compounding material in rubber mixes (used for impregnating cotton duck in the manufacture of rubber belting, rubber hose, and rubber packing).
5. As a compounding material in rubber compounds (used in the manufacture of double texture raincloths).

Although this new gutta is not of domestic origin, we feel that its interesting properties may prove of value to some of our colleagues in the organic chemical industries.

Department for Research Chemistry,
Rubber Trade Laboratory,
Newark, N. J.

High-Frequency Induction Steel-Furnace

A Practical Combination of Crucible-Melting Flexibility With the Advanced Practice of Electric Melting —A Means for Producing Alloys Whose Proportions Are Accurately Reproducible— Virtually an Electric Crucible

BY E. F. NORTHRUP

THE furnace which we here describe is one of several specific commercial applications of Ajax-Northrup High-Frequency Induction Furnaces which the Ajax Electrothermic Corporation has developed.

This specific form of furnace, which for brevity we designate as a "10-In. Conical Pouring Furnace," is designed for operation with high-frequency current supplied by a standardized high-frequency converter set of 20-kw. capacity. All furnaces which operate with high-frequency current require a frequency of from 10,000 to 25,000 cycles per second.

The high-frequency converter set is a piece of static apparatus which performs the function of converting commercial current of ordinary frequency, usually sixty cycles, into current of the high frequency required. A 20-kw. high-frequency set occupies a floor space of 31 in. front by 41 in. deep and stands 67 in. high. The set is illustrated in Fig. 1.

THE HIGH-FREQUENCY CONVERTER SET

It will be seen from the illustration that the set consists of a metallic cage faced with a switchboard. On the switchboard are mounted a control wheel for varying the power, a main line switch, an indicating wattmeter, and an alcohol dropper. This cage contains all of the parts required for a 20-kw. high-frequency converter. There are but three essential parts of the apparatus, all contained in the cage. These are: Twelve General Electric Co. condensers; a transformer of special design, made by the American Transformer Co., with internal reactances; and a discharge gap. This latter has two electrodes which are raised and lowered vertically over a surface of mercury contained in a metal container. The raising and lowering of these electrodes are effected by means of a hand-wheel on the face of the switchboard, the connection to the electrodes being made through the medium of a flexible shaft. The power delivered by the high-frequency converter set may be varied from zero to maximum by changing the distance of the electrodes above the surface of the mercury. All low-frequency, high-tension circuits are housed in the metal cage, which is itself connected to earth.

The transformer steps the line voltage up to 6,600 volts, but no danger of contact with this high voltage is possible because the high-tension parts are housed in the grounded metal cage. The high-frequency converter set, of standard construction, operates on single phase or one leg of a polyphase circuit of 220 volts and sixty cycles. When used with the furnace about to be described this set delivers current to the furnace at a frequency of approximately 15,000 cycles per second.

The set is designed for continuous operation and will have a long life, as there are no parts which are moving nor are there any parts which suffer rapid depreciation. The power which is drawn from the supply line is at all times shown by the indicating wattmeter on the face of the switchboard, and this power may be varied by the control wheel in infinitesimal steps from zero to a maximum of 20 kw. No power is wasted in rheostats or other like devices. The current taken by the set is not far different when operating with small power than when operating with large power, and consequently as the set draws more power from the line the power factor improves, reaching at full power over 70 per cent.

THE FURNACE

The furnace which it is the purpose of this article to describe and which is operated with current obtained from the above-described high-frequency converter set, has the following construction:

A strongly built box is made of asbestos board and is approximately cubical in form, being 16 x 16 x 14½

FIG. 1. VIEW OF A 20-KW. HIGH-FREQUENCY SET

in. This box contains the inductor coil, the electrical insulation, the small amount of heat-insulating material required and the crucible in which is placed the metal to be melted. For brevity we shall speak of this as "the furnace."

The furnace is placed on a table made of heavy

asbestos board. This is 20 x 36 in. and stands 15 in. high. The leads from the high-frequency converter set are permanently connected to metal pieces beneath the cover of this table. When the furnace is placed upon the table, contact is made with these metal pieces by two metal feet at the base of the furnace box. The furnace is so designed that when a melt is completed the furnace may be lifted off the table by two men using suitably designed handles and may then be tilted and the contents poured. The handling of the furnace and the pouring are done in the usual manner in which one handles and pours metal from a crucible which is lifted and rotated by a so-called "bale."

Construction of the Furnace

The construction of the furnace proper is exceedingly simple and consists of only two essential parts—the inductor coil and a crucible. The latter fits within the inductor coil, with a suitable small amount of electrical and heat insulation between the two. The inductor coil is conical in form, the large diameter of the cone being uppermost. The diameter of the base of the cone

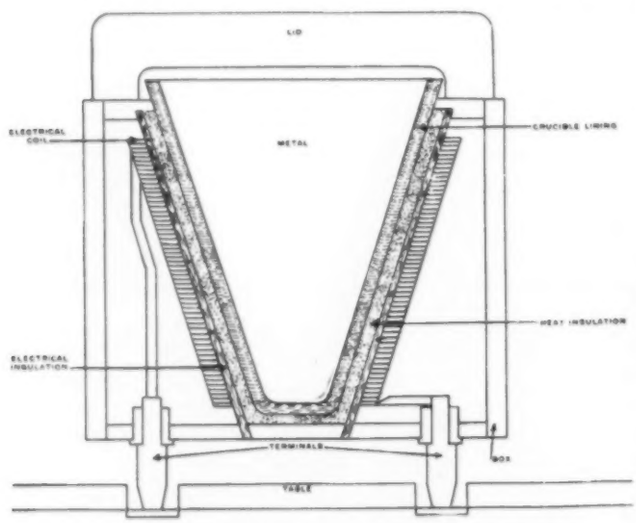


FIG. 2. CROSS-SECTION OF STEEL FURNACE

is 4½ in., the top of the cone is 10½ in., and its vertical height is 10½ in. The inductor coil itself consists of thirty-seven turns of ⅜-in. copper tubing flattened and wound edgeways. Arrangement is made for circulating a small stream of water through this copper coil both to maintain it cool and to keep its resistance low. The inside of this inductor coil is lined with a cylinder of micanite (a kind of micanite having no organic binder) about ¼ in. thick. This gives both electrical and heat insulation.

The crucible has the same conical shape as the coil and is within it. A space of about ½ in. between the outside of the conical crucible and the inside of the micanite cone is filled with a suitable powdered heat insulator, lampblack being a very suitable material for a steel-melting furnace, although electrically sintered and powdered magnesia or several other materials may be substituted for lampblack where strictly carbon-free melts are demanded. The construction is shown by the cross-sectional view in Fig. 2.

When a crucible has become used up, it is easily withdrawn from the powdered encasement of heat-insulating material and a new crucible inserted in its place. This conical crucible is designed to hold from 50 to 60 lb. of metal of the density of steel, and will melt and pour this weight of any metal of high specific resistance like a ferrous alloy which melts under 1,200 deg. C. Where metals are to be melted which require excessive temperatures, like a very low-carbon steel, it is not desirable to attempt to melt and pour at one time more than 25 lb., though it is possible to pour somewhat larger amounts. In the case of the alloy used in casting the metal parts of typewriters 50-lb. pours have been made with much success.

Features of the Furnace

Any of the metals or alloys which are to be melted can be placed in the crucible in the form of turnings or in the form of masses which may have a subdivision down to the size of a pea, but not in the form of a fine powder. The heating of these metals when above the temperature at which iron loses its magnetism is due entirely to the large currents which are induced in the mass of the metal. When the metal is magnetic, there is further development of heat due to the hysteresis losses caused by the rapid reversals of the magnetism. Iron and steel, therefore, are heated with particular facility because of this fact and likewise on account of the high specific resistance of these metals.

A feature of marked value when melting alloys is the rapid stirring which takes place in the molten metal. This stirring is not a circular motion, but an upward motion in the axis of the pool and a downward motion in the circumferential region. When the power is on, the surface of the metal is not level, but considerably crowned. This stirring action is due solely to the action of electromagnetic forces and is in no sense a heat phenomenon. Its effect in insuring a thorough mix of the components of an alloy is very beneficial. In melting steel all dross of the metal is swept upward to the surface, where it remains. It is possible to pour castings which are very clean and with the constituents of an alloy very homogeneously distributed. For example, the Western Electric Co. has been pouring with a furnace of this general type an alloy of pure electrolytic iron and pure electrolytic nickel. The metal was cast in bars about 20 in. long and ¾ in. in diameter. Repeated analyses show that the composition of these bars varied less than 0.01 per cent for portions of the metal selected from different parts of the bar. This homogeneity attainable in an alloy was found to have great value in the case of alloys used for drawing into thermocouple wires.

How a Pour Is Made

When a pool of 20 to 50 lb. of molten metal has formed in the crucible a pour is made as follows: The two handles shown in the illustration, Fig. 3, are attached to opposite side walls of the furnace. The furnace is lifted from its table by two handlers, one of whom rotates the furnace by means of the double handle and makes the pour. It is not difficult to guide the molten metal into a small orifice.

In Table I is given a typical melt made with one of these furnaces. The material to be melted was 20 lb. of steel turnings. These had evidently been gathered off the floor. They contained much admixture of dirt and oil and formed a bulky mass. At the beginning of the melt the entire furnace, including the crucible, was at room temperature. The crucible was filled to the top with steel turnings. This took about one-quarter of the 20 lb. A record of the progress of the melt taken

directly from the note book as there recorded is given in Table I.

Commenting on this melt, it may be stated that we could have continued to add turnings until 50 lb. of the material became melted; but this was not done, as no more material was at hand.

TABLE I. MELT OF STEEL TURNINGS IN 10-IN. CONICAL FURNACE*

Sample consisted of 20 lb. of steel turnings marked 2-A

Time	Kw.	Notes
12:50	15	Furnace was started at about 100° C. Furnace was packed to within ½ in. of top with steel turnings.
1:05	15	
1:06	17½	
1:07	20	
1:08	20	First charge melted at bottom. Poked down and added more steel turnings.
1:10	18	
1:11	20	
1:13	19	
1:15	18	Remainder of the 20 lb. of steel turnings was put in furnace.
1:20	17	
1:23	16	Buttom of mass melted. Poked down with asbestos-board poker.
1:24	18	
1:26	18	Metal nearly all melted.
1:28	18	Put one handful of flux on surface of molten metal.
1:31	20	Melt complete and quite fluid.
1:37	20.5	Poured melt which when cold weighed 16½ lb.

*Test by E. F. Northrup and Bert Robbins, Nov. 20, 1920.

At another time, using the same furnace and crucible, 50 lb. of the metal out of which the castings for typewriter frames are made was melted, with an average input of 17 kw., in two hours and twenty-six minutes, and five minutes later poured into molds. The metal was very fluid and fine castings were obtained. The metal is non-magnetic, and the melting was produced solely by the eddy currents induced in the irregular masses of metal placed in the non-conducting crucible. For efficient and rapid melting of a metal of this character a molded carbon or graphite crucible should be used.

FIG. 3. MAKING A POUR

Summary of Unique Features of Furnace

The unique features of this furnace may be summarized as follows:

The exterior is at all times at room temperature.

As soon as the metal becomes molten it is actively stirred by an automatic process.

The metal is maintained quite free from contaminating gases, and may be melted quite free from carbon.

The heated mass is heated very uniformly throughout, which makes it possible entirely to avoid metal losses which might otherwise result from the driving off of volatile constituents.

The upper temperature limit obtainable is exceedingly high. No conclusive tests on the maximum temperature obtainable have been made with a furnace of this size and capacity, but it may be conservatively stated that a temperature of 1,800 deg. C. may be obtained.

The control of the temperature is perfect, and inasmuch as the heat is generated directly in the melt the temperature will stop rising instantly when the power is much reduced or cut off.

The furnace permits changing from one kind of melt to another in the shortest possible time. The crucible which carries the melt can be slipped out of its powdered refractory and another put in its place in a few minutes. Thus any metal from one melt which remains on the walls of the crucible will not be present to contaminate the next melt when of a different material.

As all parts of this furnace except the crucible and the melt are substantially at room temperature, the essential parts of the furnace suffer little wear and are little likely to become destroyed. The construction is such that each of the parts of the furnace is easily replaced or renewed, and the construction as a whole is simple and inexpensive.

Sizes Available and Possible

If a sufficient supply of high-frequency power is available this same general type of furnace could be constructed to melt steel in tonnage lots. At the present time, however, the only furnace for this purpose which has been commercialized as a market product is of the size and character described in the foregoing.

Use of This Type of Furnace for Non-Ferrous, High-Conductivity Metals and Alloys

Such metals as brass, copper, gold and silver have too high conductivity to be melted with any satisfactory efficiency by direct induction. To adapt the furnace, therefore, for melting metals of this character it is only necessary to supply a crucible of molded carbon or graphite to replace, or if preferred, to fit into the crucible of non-conducting material used for melting materials of low conductivity. When the furnace is furnished with a crucible of conducting material, the heat is generated directly in the walls of the crucible, and this heat is transmitted to the metal contained in the crucible by conduction and radiation.

A furnace of the size and character described, and arranged for melting copper and energized by a standard 20-kw. high-frequency converter set will melt about 85 lb. of copper an hour, or between 600 and 700 lb. in an eight-hour day.

The theory and possibilities of heating with high-frequency currents were fully set forth by the writer in a paper read at the meeting of the American Electrochemical Society held in New York City April 3, 4 and 5, 1919, the title of his paper being "Principles of Inductive Heating With High-Frequency Currents."

The furnace which it has been the purpose of this paper to describe is only one of many types which have been developed for operation with high-frequency current. Their usefulness has been established in many laboratories and in several industrial plants.

The advantages of heating by high-frequency induction are continually being more thoroughly impressed on the minds of heating engineers. The author personally feels this application of electric methods offers more promising possibilities than almost any other development being made at the present time.

Experimental Shale Oil-Retorting Plant

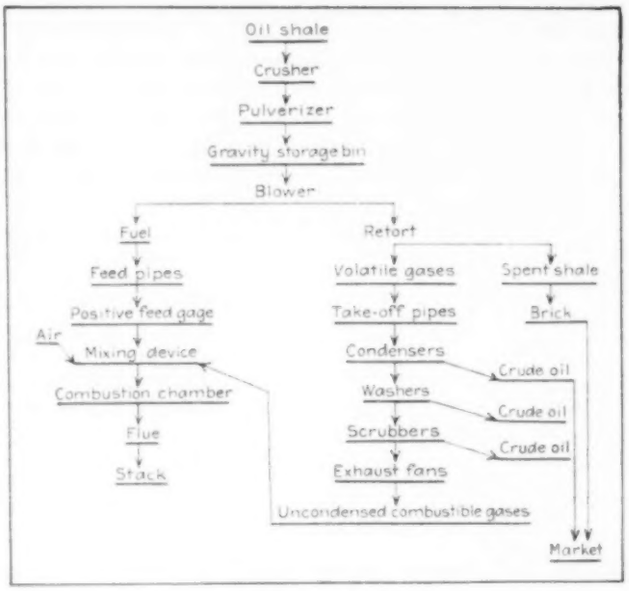
AN INTERESTING development in the process of retorting oil shales is now being tested in a 15-ton commercial unit by the Shale Oil Refining Corporation, of New York, at Denver, Col., using the Johns eduction process.

The shale is first crushed and pulverized so that it passes a ¼-in. screen and is then elevated by a conveyor to a storage gravity feed box. From this box a small portion of the material, mixed with air and non-condensed combustible gas from the retort, is forced by a blower into the combustion chamber under the retort, where it is used as a fuel.

The remainder of the pulverized product is fed into the retort and distilled. A mechanical scraping device spreads about 500 lb. of the crushed shale in a thin even layer about 1¼ in. deep over the bottom of the retort, and at the same time progressively moves the material through the retort. By this means the entering shale is subjected to the lowest temperature, and then as it moves along the temperature is increased until by the time the particles reach the hottest part at the lower end of the retort all the oil has been driven out. This process is continuous and takes about twenty-five minutes. The spent shale drops off into either a water or a dry seal and is removed by scraper belts. It may be utilized for the manufacture of brick or for other purposes.

The unit retorts are 23 ft. long, 4½ ft. wide, about 5 ft. high in front and 9 ft. in back and are constructed with a concrete base and ordinary firebrick walls with firebrick lining for firebox and flues. The heating chamber itself extends the entire length and width of the retort and is about 9 in. high. The top is composed of angle-irons and sheet metal plates, laid in loose and covered with sand as a seal. A scraper device is also attached to the top for turning over and moving along the shale on the retort. Lugs are fitted to the top so that it can be lifted off as a unit and repairs easily made on the retort.

Carborundum tile is being substituted for the firebrick because, due to its greater heat conductivity, it is expected that the capacity of the plant will be increased greatly.



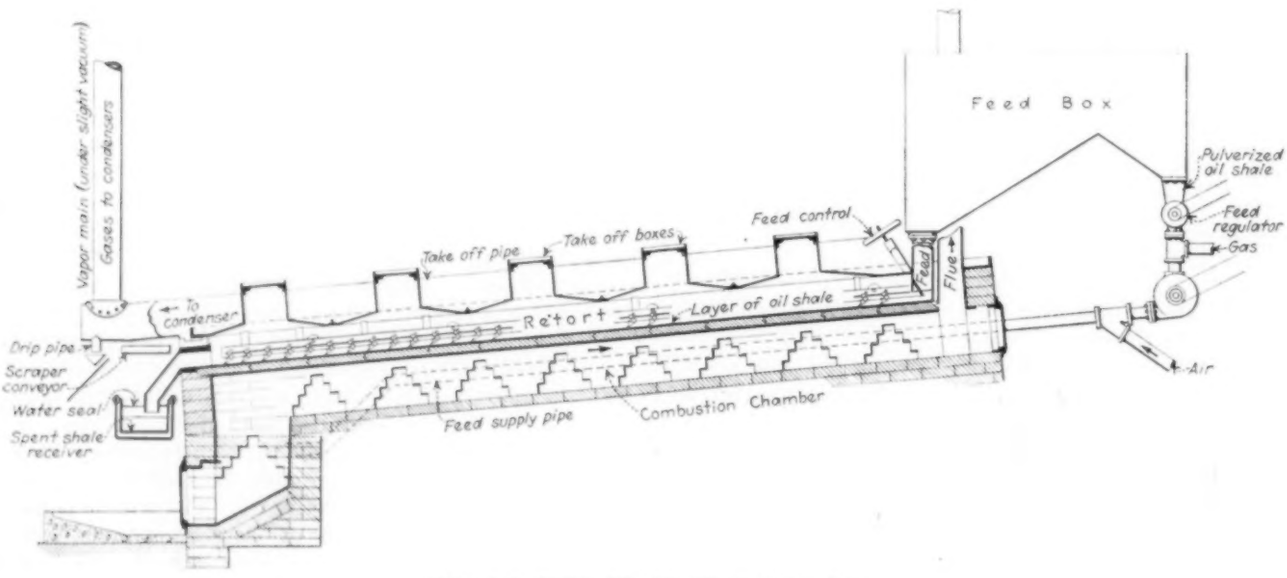
FLOW SHEET

Take-off boxes suitably arranged at various intervals in the top of the retort are designed to carry off the liberated oil vapors to the vapor main as quickly as possible so as to minimize cracking by further heating. The vapors are then carried to the condenser, where they are cooled and crude oil obtained.

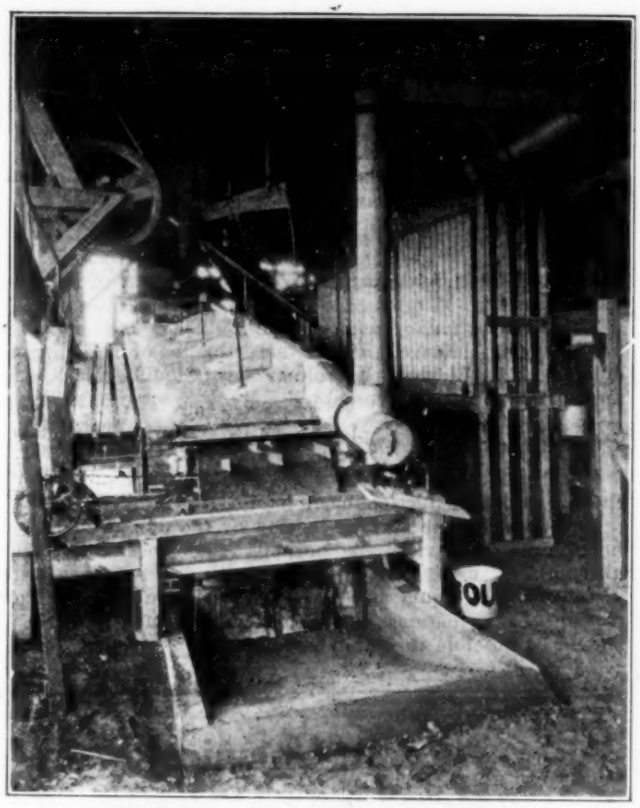
Pyrometers installed at various points enable the workmen to check and control the temperature at any desired point and thereby obtain a more uniform product.

To test certain operating conditions a number of runs have been made. One was of fifty hours duration, two of eighty hours and one of five days. In October, 1920, a test was made before the Oil Men's Convention, to demonstrate the process on a commercial scale.

Samples of distillate taken from four points—the foul main, the first and second condensers, and dry coke scrubber—after being separated from the water and redistilled were found to give a smooth flowing black



CROSS-SECTION OF OIL SHALE RETORT



GENERAL VIEW OF RETORT AND CONDENSER

oil at ordinary room temperature. According to distillation figures, 20 per cent of oil was distilled under 437 deg. F.) 80 per cent at 725 deg. F. and 92 per cent of distillation was carried on till coke formed.

The light oils taken by the absorber oil amounted to only 2 per cent of the total but, for shale oil, this light fraction is of an extraordinarily high gravity and of a low percentage of unsaturated compounds, and could be used to improve the character of the oil obtained from the condensers or else refined by itself.

A 50-ton testing plant, together with an up-to-date laboratory, is to be built by the company in the vicinity of New York City for the purpose of experimenting with oil shales shipped from foreign countries.

Sugar Exports From Cuba to the United States

The increased price of sugar accounted for the large increases in the value of the declared exports from Cuba to the United States during the past year, as compared with 1919, which are shown in the following table:

Items	1919 Lb.	1919 Value	1920 Lb.	1920 Value
From Antilla				
Sugar	635,663,650	$37,345,087	585,108,839	$78,499,816
All other articles		1,478,444		2,506,106
Total		38,823,531		81,005,922
From Cienfuegos				
Sugar	589,617,280	35,172,742	322,524,800	39,470,078
All other articles		1,528,273		1,527,108
Total		36,701,015		40,997,186
From Caibarien				
Sugar	416,243,525	22,509,079	389,943,850	44,798,841
All other articles		84,782		70,066
Total		22,593,861		44,868,907
From Sagua La Grande				
Sugar	464,309,029	25,107,844	447,391,290	50,420,446
All other articles		268,083		454,654
Total		25,375,927		50,875,100

Synopsis of Recent Chemical & Metallurgical Literature

Synthetic Preparation of Humic Acids.—In the Jan. 10 issue of *Chemical Abstracts*, p. 83, there is a record taken from the *Berliner Berichte* (vol. 53, pp. 1469-76, 1920) of an achievement of leading interest contributed by Wilhelm Eller and Kaete Koch. In this they show that the deep black-brown products formed by the oxidation of phenols in alkaline solution are humic acids. It appears, however, that only such phenols yield humic acid as can, in some way, pass through a quinoid stage as an intermediate product. Thus m-$C_6H_4(OH)_2$ forms no humic acid, whereas the compounds obtained from the ortho and para bodies and from quinone have the composition $C_6H_4O_2$. The proof of the identity of this oxidation product with the natural humic acids is difficult, but their physical properties and chemical reactions are such as to leave no doubt of it in the minds of the authors. They hold that there is but one humic acid, but that different phenols yield different humin substances. The nitrogen in natural humic acid is said to be due to impurities. The acid reaction of humin substances, on the other hand, is not due to impurities, but to unchanged phenolic OH groups.

Use of Aluminum for Electric Transmission Lines.—The September, 1920, issue of *Annales des Postes, Télégraphes et Téléphones* contains an important article on the use of aluminum for electric transmission lines by M. DUSAUGEY.* The author, after passing in review the history of the manufacture of aluminum and the important manufacturing concerns in Europe and America, describes the different phases leading to the adoption of aluminum in the electrical transmission industry and to the official specifications of 1913 for aluminum electric conductors. During the war a special official French commission, of which the author was one of the members, made a thorough study of the chemical and mechanical properties of the aluminum to be used and summarized the data obtained under the captions chemical composition, mechanical resistance, limits of elasticity and elongation, softeners and electric conductivity, also giving a long comparative table of the properties of commercial aluminum and copper.

A 99 per cent aluminum containing no other impurities than iron and silicon, with traces only of oxygen and carbon, gives the best practical results. He then enumerates the mechanical properties required and states that it is a very simple matter to obtain the appropriate metal which would enable the substitution of aluminum for copper in transmission cables, with a reduction in weight of half of that of copper for equal electric conductivity. He even states that for high voltage transmission lines (100,000 volts) aluminum is far more efficient than copper. Taking the weight of copper as 100, the author gives the following ratios between the weights of aluminum and copper:

For equal section of conductors	30 : 100
For equal heating of the conductors during the passage of the same current	42 : 100
For equal conductivity	50 : 100

The first ratio is of value especially for telephone and telegraph lines. If m is the ratio of the prices of aluminum and copper the percentage of gross economy realized by the use of aluminum is $e = 100 - 30m$.

The second ratio is of value in cases of interior conduits where the heating of the conductors plays an important part. Here the percentage of gross economy realized by the use of aluminum would be $e_1 = 100 - 42m$.

The third ratio is of value wherever electric conductors are used, and the percentage resulting from the use of aluminum instead of copper would be $e_2 = 100 - 50m$.

With copper, say, at 15c. per lb. and aluminum at 27.5c.

*L'Aluminium et son application aux lignes électriques: *Annales des Postes, Télégraphes et Téléphones*, M. Dusaugey, September, 1920, pp. 366-412.

per lb., the respective economies would be $e = 46$ per cent, $e_1 = 24.4$ per cent, and $e_2 = 10$ per cent.

The following table summarizes partially the comparisons of the different types of electric conductors.

	Commercial Aluminum	Commercial Copper	Aluminum-Steel, 7 Strands	Aluminum-Steel, 37 Strands
Specific weight, g. per c.c.	2.7	8.95	3.55	3.85
Electric conductivity (relative)	60.0	100.0	51.5	49.0
Coefficient of linear expansion	22×10^{-6}	16×10^{-6}	18.2×10^{-6}	17.25×10^{-6}
Breaking limit, kg. per sq.mm.	20	42	29	32
Coefficient of elasticity, kg. per sq.mm.	11 to 12	21 to 25	16	17 to 18
Ratio of sections for equal conductivity	1.666	1	1.943	2.05
Ratio of the diameters for equal conductivity	1.29	1	1.395	1.43
Ratio of the weight for equal conductivity	0.5	1	0.73	0.835

The article concludes with a note giving the official methods for the quantitative analyses for silicon and iron, the aluminum percentage being obtained by difference.

Determination of Silicon: A 2-g. sample is placed in a 250-c.c. porcelain dish. Add 50 c.c. of a mixture consisting of

	c.c.
Nitric acid, c.p. (density 1.42)	100
Hydrochloric acid, c.p. (density 1.2)	300
Sulphuric acid, c.p. (density 66 deg. Bé.)	100
Distilled water	100

Ten to 12 minutes is required for complete solution at normal temperature. When the metal is completely dissolved add 15 c.c. H_2SO_4 c.p. and heat until white fumes appear; cool; add 100 to 150 c.c. H_2O, boil, filter, wash free from sulphates, dry, ignite, cool, weigh. The result is SiO_2, which is figured to silicon.

Determination of Iron: A 2-g. sample is placed in a 500-c.c. flask. Add 50 c.c. of the mixture

	c.c.
Hydrochloric acid, c.p. (22 deg. Bé.)	500
Distilled water	500

Solution takes place at normal temperature or better when heated slowly. When the reaction is completed (no more bubbling) and with a pipette 50 c.c. of preventive solution consisting of

Manganese sulphate, c.p., grams	50
Phosphoric acid, 65 per cent, c.c.	100
Sulphuric acid, c.p., c.c.	100
Distilled water to complete up to c.c.	1,000

Add now 150 c.c. H_2O and titrate with a $KMnO_4$ solution each c.c. of which is equivalent to 2 mg. Fe.

Surface Tension and Capillary Flow.—In a paper under the title, "The Dynamics of Capillary Flow," read before the American Society for the Advancement of Science, Physics Section, Dr. Edward W. Washburn described a new, very accurate and quite simple method for the measurement of surface tension. For a horizontal tube l cm. long and of the average radius r the flow during the time t will be according to the equation

$$l^2 = \frac{\gamma \cos\theta\, rt}{2\eta}$$

where γ is the surface tension, θ the angle of contact, η the viscosity and $\frac{\gamma \cos\theta}{2\eta}$ might be called the coefficient of penetration. The tube may be of almost any length, making the method very accurate. If there is any difference in air or hydrostatic pressure at the two ends of the tube, it must be added to the surface tension.

Statical problems connected with the rise of liquids in capillary tubes have been investigated on both the theoretical and the experimental side, but the dynamical aspects do not appear to have received much attention. Aside from the theoretical interest attaching to the subject, the dynamics of capillary flow have certain practical aspects in connection with the movements of water or oil through soils, the impregnation of wood and other porous materials with liquids, and the determination of the porosity and true density of porous bodies, as well as offering a new method for measuring the surface tension or viscosity of a liquid.

The rate at which a liquid penetrates a small cylindrical capillary of radius r was shown to be

$$\frac{dl}{dt} = \frac{P(r^3 + 4er)}{8\eta l}$$

where P is the driving pressure, e the coefficient of slip and η the viscosity.

The Penetration of a Porous Body by a Liquid. If a porous body behaves as an assemblage of very small cylindrical capillaries, the volume V of liquid which penetrates it in time t is given by

$$V = k\left(\frac{r}{\eta}t\right)^{\frac{1}{2}}$$

Experiments with mercury, water and other liquids verify the theoretical deductions completely.

In measuring the surface tension by the dynamic method, horizontal capillaries are perhaps the most convenient, although by using the vertical capillary immersed some distance in the liquid and allowing the liquid to drop from a point some distance *beyond* its equilibrium position, it should be possible to obtain good results.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Continuous Cyanamide Furnace.—Reactions between carbides and nitrogen may be carried out continuously in an annular furnace provided with an endless base plate or table. This table rotates and conveys the carbide which is placed upon it through a counter-current stream of nitrogen. Just before reaching the feeding hopper the finished material is removed by a scraper and discharged from the furnace. The carbide is preferably placed on a layer of inert substance rather than directly on the moving ring. By regulating the temperature and the flow of nitrogen, the reaction is readily controlled. (1,364,157; VICTOR THRANE, of Christiania, Norway; Jan. 4, 1921.)

Separation of Meta- and Para-Cresols.—Commercial cresylic acids contain ordinarily the three isomeric cresols in the same proportions relative to each other as they occur in coal tar. Ortho-cresol may be very completely removed from this mixture by column distillation, but since the boiling points of meta- and para-cresol are so nearly the same, chemical means must be used for their separation. Since it has been found that meta-cresol is more easily sulphonated than para-cresol, several methods have been proposed for the separation of these two compounds by sulphonating the former and removing the unsulphonated latter by means of a solvent. The residue is steam distilled at atmospheric pressure around 110 deg. C. to break up the meta-cresol mono-sulphonic acid. According to this procedure there is present in the reaction vessel a relatively large excess of concentrated sulphuric acid at the start and a large amount of dilute acid at the finish. This is objectionable because the concentrated acid tends to sulphonate more para-cresol than is desirable and because there is a large amount of dilute acid which is unreactive which increases the cost of the operation. CHARLES R. DOWNS of Cliffside and RALPH S. POTTER of Grantwood, N. J., have discovered that by sulphonating with SO_3 in the vapor phase excess sulphuric acid is avoided and that by diluting with an equal volume of water and vacuum distilling at 70 deg. C., the unsul-

phonated para-cresol distills over. It is recovered from the condensate by extraction, cooling and centrifuging. If it is merely desired to produce a meta-cresol of 80 per cent purity, the vacuum is released and the sulphonated residue in the still is decomposed by heating to about 120 deg. C. and injecting steam. If a meta-cresol of higher purity is desired the sulphonic acid is crystallized out by cooling, filtered off and decomposed by steam. (1,364,547; assigned to The Barrett Co.; Jan. 4, 1921.)

Cyanides and Rich Producer Gas.—The following modification of the process for making cyanides by passing nitrogen over C, Na_2CO_3 and Fe is proposed by RICHARD FRANCHOT, of Niagara Falls: Gas containing 34 to 35 per cent CO is made in a slagging gas producer charged with coke, anthracite or bituminous coal as fuel, limestone as flux, and run with a hot blast so that temperatures of 1,400 to 1,500 deg. C. are reached in the hot zones. This gas is passed over balls or bricks made of magnesia 20 per cent, coke 15 per cent, soda ash 15 per cent and iron or its equivalent as oxide 50 per cent. In the reaction which ensues nitrogen combines to form alkali cyanide and the oxygen in the soda ash is converted into carbon monoxide. As a result the CO content of the gas is increased to over 40 per cent, while the temperature drops from 1,400 to 800 deg. C. The balls are leached or steamed to recover cyanide or ammonia, and re-used until they break down physically. They are then added to the charge in the producer. The iron is melted and may be collected in the usual way, while the silicates, etc., are slagged and the sodium content converted into cyanide, which volatilizes and deposits on the briquets. (1,364,838; assigned to Ferro Chemicals, Inc.; Jan. 4, 1921.)

Nitric Acid.—When sulphuric acid and sodium nitrate are mixed in a still or receptacle there occurs a violent chemical reaction, which results in a high pressure, and in the systems now generally employed this pressure often results in the loss of a large part of the gases due to portions of the system or apparatus being blown apart, and particularly blowing out the putty at the joints of the bleachers and condensers. This difficulty may be overcome by the use of an expansion chamber of 14 in. chemical ware or Duriron pipe, into which the gases from the battery of twenty stills are allowed to escape and mix freely. This results in a more even flow of gas to the bleachers—five in number—in which the acid flowing down from the condensers is bleached by the action of the hot gases about to enter the condensers. (1,361,416; CHARLES L. TAYNTOR, of Claymont, Del.; Dec. 7, 1920.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

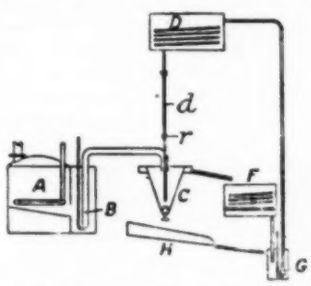
Non-Fragile Glass.—Non-fragile glass, which can be rolled, forged, extruded, cast, etc., is made by dissolving in the dry state such silicates as micaceous or asbestos minerals in molten glass or similar silicate. The glass, etc., is chosen so as to melt at a temperature below the temperature at which the mica, etc., effloresce. If the product is to be machined, an excess of mica, etc., should be present over the amount required to form a saturated solution. (Br. Pat. 152,780. P. B. GROSSLEY, Calcutta, India; Dec. 31, 1920.)

Purification of Zinc.—In the purification of zinc solutions, and in particular the preparation of zinc solutions for electrolysis, silica is separated in a filterable form by adding an alkali or alkaline earth carbonate in slight excess to the neutral or substantially neutral liquor, at an elevated temperature. In an example, a ground zinc sulphide ore is roasted to convert to oxide and sulphate and then after re-grinding is added to hot sulphuric acid of 10 to 15 per cent strength, which may be that obtained from the electrolytic cells. When the acidity has been reduced to 5 per cent, it is still further diminished to 1 per cent by the addition of a mixed precipitate of zinc oxide and carbonate and iron oxide, obtained in a subsequent stage in the purification. Neutralization is finally attained by adding whitening in the form of powder or of a milk made with water. The silica is then precipitated by adding about 10 lb. of whitening per ton of liquor and maintaining the temperature at 90 to 100 deg. C. for a short time with agitation. After filtration, the silica is washed with water to free it from zinc. (Br. Pat. 152,752. F. PETERSON and METALS EXTRACTION CORPORATION, London; Dec. 31, 1920.)

Coating With Copper.—A copper-salt solution is reduced by hydrazine hydrate in the presence of ammonia, the copper being deposited as a coherent coating on heated, non-conducting, smooth or polished surfaces, such as glass, china, porcelain and the like, in contact with the solution. The coating liquid can be prepared by adding strong copper sulphate solution to a strong solution of hydrazine sulphate in hot water until a faint blue color persists on standing and a pale-blue powder is precipitated. If not for immediate use, the powder may be filtered and dried. When used, it is suspended in cold water, a few drops of cold hydrazine sulphate solution added, followed slowly by a solution of ammonia until the liquid turns dark brown, when caustic soda solution is added until a slight yellow or orange precipitate persists after shaking. The precipitate is dissolved by a little hydrazine sulphate, yielding the clear yellowish or brownish liquid required. (Br. Pat. 152,835. J. D. SMITH, The University, Birmingham; Dec. 31, 1920.)

Ultramarine.—Sulphites or bisulphites of the alkalis or mixtures of these salts are used in the manufacture of blue or green ultramarines to replace wholly or partially the alkali carbonates or sulphates usually employed. The sulphite of soda obtained as a byproduct in the preparation of phenol is particularly suitable for this purpose. In an example, the furnace charge consists of kaolin, sulphite of soda, sulphur and a reducing agent such as resin. (Br. Pat. 152,916. J. B. GUIMET and A. GUILLOCHIN, both of Fleurien-Sur-Saone, Rhone, France; Dec. 31, 1920.)

Purifying Ammonium Sulphate.—The coloring matter usually associated with crystals of ammonium sulphate is removed by agitating the latter, in a detached condition in a clear saturated solution of that salt, maintained slightly acid—if necessary by the addition of sulphuric acid—and floating of the suspended impurities. The agitation may be performed mechanically, or by blowing with air or steam, but preferably it is effected by means of the saturated ammonium-sulphate solution, which enters at a point near the bottom of the conical-shaped treatment vessel containing the crystals. The rapid stream on entering stirs up the crystals, but as the diameter of the vessel increases only the impurities remain suspended. The accompanying figure shows the saturator *A* from which crystals are removed to the vessel *C* by means of steam lift *B*. A stream of filtered saturated ammonium sulphate enters by pipe *d*, and is regulated by valve *r*. The temperature of the liquor throughout the system is maintained at the same temperature as the crystals coming from the saturator by means of steam coils in the storage tank *D* and the filter *F*. The clean crystals are dischaged periodically on to the drainer *H*, the liquor collecting in the sump *G*, from which it is raised to tank *D* by means of an air lift. An ordinary saturator may also be adapted for the process. Crystals having been deposited, the passage of ammonia is reduced or stopped. A filtered saturated solution of sulphate of ammonium is supplied near the bottom of the saturator and overflows through a launder and passes to the filter as previously described. (Brit. Pat. 152,766. R. LESSING, London; Dec. 31, 1920.)



Treating Zinc.—Finely divided zinc or zinc dust for use in the purification of zinc solutions prior to electrolysis, for precipitating metals from cyanide or other solutions and as a reducing agent in the preparation of organic compounds is treated with a view to increasing its activity. The zinc may be stirred with boiling water or with a solution of an alkali such as caustic soda. (Br. Pat. 152,997; not yet accepted; ELECTROLYTIC ZINC CO. of Australasia Proprietary, Melbourne, Australia. Jan. 12, 1921.)

Current Events
in the Chemical and Metallurgical Industries

American Ceramic Society to Meet in Columbus

The program of the twenty-third annual meeting of the American Ceramic Society, which occurs at the Hotel Deshler, Columbus, Ohio, Feb. 21 to 24, is on the press and will shortly be in the hands of members.

Nearly twice as many acceptances as last year have been received by the secretary, and over one hundred papers are on the program. The Divisions of Enamels, Glass, Refractories and Terra Cotta will have separate meetings on Tuesday, Feb. 22, with divisional papers. At the same time conferences will be held, with informal discussion, of three groups—Decorative Processes, Heavy Clay Products and White Ware—with a view to the formation of divisions.

The local committee is making attractive plans for entertainment. Section Q, on Monday evening, is open to members and guests, and the events of the evening are shrouded in secrecy. Nobody knows what is going to happen, therefore everybody will be present to find out. The banquet will be held in the spacious ball room of the hotel on Tuesday evening. Special plans are being made for the entertainment of ladies who accompany members.

Department of Agriculture Criticizes Use of Poison Gas for Boll Weevil Control

For the past eight months the Chemical Warfare Service has been engaged in a conscientious effort to be helpful in the matter of boll weevil control. The chemists connected with the Chemical Warfare Service are hopeful that war gases can be used to the benefit of the cotton growers, who suffer losses aggregating hundreds of millions of dollars each year, due to the ravages of the boll weevil. The Department of Agriculture not only has no faith in the successful outcome of the experiments being conducted by the Chemical Warfare Service, but on Feb. 9 issued an official statement the effect of which was to ridicule the idea of any such use of poison gases. Officials of the Chemical Warfare Service resent this attitude on the part of the Department of Agriculture. The statement was issued without conferring with the Chemical Warfare Service and without any effort having been made to ascertain what that branch of the Government service had done in the way of experimentation. As a matter of fact, the work had reached a point where it was being carried on jointly by the C. W. S. and the Agricultural Department of Georgia.

The Department of Agriculture took particular pains to deny a published statement to the effect that the work is being carried on in co-operation with it. It is true that no co-operative contract exists between the two federal agencies, but before embarking upon the experiments, the chief chemist of the Warfare Service conferred with the specialists of the Bureau of Entomology and was assured that they always stood ready to help any plan which had as its object a more effective control of the boll weevil. Supplied with data from the entomologists which would prevent duplication of any work that had been done, the Chemical Warfare Service proceeded with its experiments. No claims have been made for any successes, but when the proper time comes it is admitted that there may be something of a surprise in store for even the department which has been working on this problem with rather qualified success for a long period of years.

Fertilizer Report Soon

A comprehensive report on the fertilizer situation will be made to Congress soon by the Bureau of Soils of the Department of Agriculture. The report is being made in response to a Senate resolution and will contain comment as to prices and the general fertilizer situation.

Approved Patents for Government Employees

The conferees on the Patent Office bill have reached an agreement which includes the proposal that the Federal Trade Commission administer patents issued to Government employees. The conferees also agreed upon the salary scale approved by the House. The Senate made material reduction in this salary scale, but the conferees approved the higher salaries. In fact the bill, as passed by the House, was approved in almost all particulars. The real point of issue in the conference was the retention of the Government employee patent feature of the measure. No opposition of consequence is expected when the conference report is brought up for acceptance. The bill provides important revisions in the procedure in the Patent Office. The section referring to the handling of Government employee patents reads as follows:

> That the Federal Trade Commission be, and hereby is, authorized and empowered to accept assignment of, on behalf of the United States, under such regulations and in such manner as the President shall prescribe, inventions, patents and patent rights which said commission deems it to the advantage of the public to be so accepted, as these may from time to time be tendered it by employees of the various departments or other establishments of the Government except employees of the Patent Office, and to co-operate, as necessity may arise, with scientific or other agencies of the Government in the discharge of the duties herein set out, and the Federal Trade Commission is hereby authorized and empowered to license and collect fees and royalties for licensing said inventions, patents and patent rights in such amounts and in such manner as the President shall direct, and shall deposit the same with the Treasurer of the United States; and of the total amount of such fees and royalties so deposited a certain per centum, to be determined by the President, shall be reserved, set aside and appropriated as a special fund to be disbursed as directed by the President to remunerate inventors for such of their inventions, patents and patent rights contemplated by this section as may prove meritorious and of public benefit. Provided, That nothing herein shall be construed to give to said commission or any other governmental agency any authority to engage in the manufacture of any such invention or patented article.
>
> The Commissioner of Patents is hereby directed to grant all patents and record all assignments and licenses contemplated by this section without the payment of any fee.

Symposium on Corrosion

At the coming Atlantic City meeting of the American Electrochemical Society (April 21 to 23) one of the sessions will be devoted to a symposium on Corrosion—in particular, electrolytic corrosion. Among those who will participate are Messrs. A. S. Cushman, D. M. Buck, W. H. Walker, James Aupperle, H. S. Rawdon, F. N. Speller, O. W. Storey, Richardson, Shephard and Gardner. Although most of the discussion will be concerned with the corrosion of iron and steel structures, a number of the papers will be devoted to the disintegration of lead and other nonferrous metals. The subject of corrosion has been growing in importance owing to the ever-increasing number of electric railway installations, buried cables, metal roofings and inclosures, large metal gas holders, storage tanks, etc. Corrosion is the one topic that interests men of almost every profession: the architect, the electrical engineer, civil engineer, metallurgical and chemical engineer, railroad engineer, surgeon, dentist, paint-chemist, geologist, etc. The Electrochemical Society's symposium on the subject will be the most complete yet organized.

Kiln Drying Course at Forest Products Laboratory

The February course in practical kiln drying will be given at the Forest Products Laboratory, Madison, Wis., Feb. 14 to 25. Instruction in these courses is not confined to any particular kind of kiln, although methods of drying different species of lumber and operation of various types of kilns are discussed. Emphasis is laid on the underlying principles of successful kiln drying and these can be adapted to any conditions. This course will be conducted much like the preceding ones, which have proved more popular than was expected.

Meeting of the American Ceramic Society, Chicago Section

The Chicago Section of the American Ceramic Society met at the City Club on Saturday, Feb. 5, for luncheon and subsequent technical program.

D. T. Sweely, of the Coonley Manufacturing Co., presented a paper on the acid resistance of enameled cooking utensils, which consisted of a series of notes to be given in more detail at the annual meeting of the Ceramic Society in Columbus this month.

Lester T. Wilson, superintendent of the Chicago plant of the National Lead Co., gave an interesting talk on the manufacture of lead products used in the ceramic industry. He described briefly the course of lead from the ore at the mines to the finished product, with references to the old Dutch, Carter and Lennox processes of making white lead and the methods of manufacture of red lead and litharge.

Of all the products which the ceramist purchases for his glazes nothing is perhaps more pure than lead, which has an average purity of 99 96 per cent. The copper content is always low, because copper alloys with lead in the proportion of 0.001 per cent only. The iron found in lead products, which is of course detrimental to the glazes, usually comes from the machinery in which the material is ground. Since the ceramist is interested chiefly in the actual metallic lead content of compounds, he should be careful to compare his market rates in determining whether to purchase white lead, litharge or red lead. The methods of determining weight per cubic inch in lead compounds is not a good test for determining the settling rate of the material in glazes. What the ceramist should determine is the real specific gravity.

The ill effects upon workers with lead are usually greater in plants using lead products than in lead manufacturers' institutions, because the latter realize the danger and take the necessary precautions. The lead industries have practically been legislated out of France and it is interesting to note the present legislation in the United States. There are many means for preventing lead poisoning, all of which the lead producer will gladly make available to the user of the product.

A resolution was passed at this meeting to call to the attention of the American Ceramic Society at the Columbus meeting the necessity for requesting the Lead Institute to furnish all ceramists with necessary information for preventing lead posioning in clay-working plants.

X-Rays in Industry

Dr. John S. Shearer. of Cornell University, addressed the Connecticut Valley Section of the American Chemical Society in Waterbury, Feb. 5, speaking on "Some Recent Applications of X-rays in the Study of Metals."

In the course of his talk Dr. Shearer sketched briefly the history of the development of our knowledge of X-rays from the time of their discovery a quarter of a century ago. This development. he said, was twosided; on one hand the constant improvement in apparatus culminating in 1913 with the Coolidge hot cathode tube; on the other, a growing knowledge of the laws governing this powerful aid to science, also culminating in 1913 with the work of Laub, who was the first to go beyond studying X-rays by means of absorption.

With powerful sources of X-rays to work with and with the use of crystals for diffraction gratings, thereby rendering it possible to know the positions of atoms in the molecule, a tremendous advance in the study of the fundamentals became possible. Advance in this direction has hardly begun. Phenomena depending upon atomic arrangement, such as amorphous films, surface tension, self-annealing, season cracking, dispersion of excess constituents, may evidently be studied directly with the X-ray, thus securing data which will prove or disprove many accepted theories based only on inference.

Dr. Shearer did not believe that the X-ray would ever become valuable as an instrument for control work, but it has great possibilities in the perfection of processes and study of causes of failure with an eye toward their removal. It is important to note that its use does not injure the specimen.

During the war X-rays proved valuable in investigating the condition of loaded rifle shells. It was possible to check up on the performance of the loading machinery and tell whether or not it was functioning properly; also jacketed bullets could be tested.

Not only metals but wood can be examined. The grain of wood shows up very clearly in an X-ray photograph, and varnish or any other protective coating makes no difference. Consequently the X-ray was used to some extent in airplane construction inspection to see that inferior woods were not substituted for spruce.

In conclusion Dr. Shearer warned his hearers that there were two sources of danger in the use of modern X-ray apparatus: the high tension current used for generating them and the rays themselves, for X-ray burns are quite serious. On the practical side great difficulties must be overcome before X-rays can become useful except in especially trained hands. There is no "foolproof" source of them yet developed.

Research in Explosives and Nickel

Some benefits to industry resulting from research scientifically conducted were interestingly stated by Dr. Charles L. Reese, chemical director, E. I. du Pont de Nemours & Co., and A. J. Wadhams, general superintendent, International Nickel Co., in addresses before the Division of Engineering of the National Research Council on Friday, Feb. 4, at the Engineers' Club, New York.

Dr. Reese emphasized the value to industries of organized research in particular. Some research projects are not immediately productive of financially profitable returns, others yield great savings or large profits immediately. If research be properly organized, or conducted on a co-operative basis by one great industry or a group of industries, a winning average from the accountant's method of keeping score is much more likely to be made. Organization and co-operation, however, must be so conducted that the individual research worker feels no restraint.

Mr. Wadhams told of the hurdles research had to take successfully in order to become established in old industrial plants. Three groups particularly required "converting" the directors, the shop superintendents and the foremen. Success depends largely upon the human qualities of the research personnel and their ability sincerely to recognize the value of the knowledge gained by the practical man in his experience, as well as the knowledge of the laboratory.

Galen H. Clevenger, consulting metallurgist, U. S. Smelting & Refining Co., Boston, presided at the meeting of the Division of Engineering, at which there were present twenty-two members and guests, men of high standing as research specialists or executives in leading industries. The Division's work is directed toward stimulation of research in the industries and bringing about co-operation in the acquisition of new scientific knowledge and its dissemination among engineers and managers of our industries. The division is supported by the National Research Council and by Engineering Foundation, representing the great national societies of Civil, Mining, Metallurgical, Mechanical and Electrical engineers.

Chemists Oppose Packers' Bill

Information reaching Washington is to the effect that manufacturing chemists, as a rule, are opposed to the bill for regulating the packing business. While sentiment among them is thought to be against any expansion of federal regulation of private business, there is a particular reason in the case of the packer bill, since the control is extended to the byproducts of the packing industry. A strict interpretation of the bill probably would enable this federal control to ramify into the fertilizer industry and other chemical activities using any of the byproducts of the packing industry.

The Haugen bill is regarded as being much more desirable than the Kenyon bill, which was passed recently by the Senate.

Dr. Smith Speaks on "Research"

A joint meeting of the New York Sections of the American Electrochemical Society, American Chemical Society, Society of Chemical Industry and Société de Chimie Industrielle was addressed by Dr. Edgar F. Smith Friday, Feb. 11, at Rumford Hall.

Dr. Charles A. Doremus presided. In his introductory remarks he made allusion to the work done by Dr. Smith as a historian of the early American chemists, and outlined some of the activities of James Woodhouse, founder of the first chemical society in America, and of Robert Hare, who did great pioneer work in electrochemistry. He compared this work to that of Benjamin Franklin and showed that the experiments of these two great American philosophers have been of the greatest importance to the development of applied science.

Dr. Smith gave a very interesting talk on "Research," in which he stated that research is a great work, but that to do it successfully the chemical investigator needs to be armed with sound preliminary education in general chemistry and other academic studies so as to enable him better to correlate the results of his work.

Tariff Free List Under Consideration

Consideration of the free list schedule of the tariff bill was begun by the Ways and Means Committee of the House of Representatives on Feb. 11. Many of the raw materials used by chemists are included in this schedule. If these raw materials are to be removed from the free list and made dutiable, it will be necessary to revise the duties asked on manufactured chemicals, since the cost of production would be enhanced by a duty on raw materials.

Since the interest in the articles on the free list is mostly of an individual character, there was concerted action among the manufacturing chemists on comparatively few items. The opposition to a duty on iron pyrites, however, was unified. Since sulphuric acid is such a basic material, the consensus was that pyrites should be continued on the free list.

All Hope for Nitrogen Corporation Bill Dies

Senator Underwood, who championed the bill authorizing the establishment of the U. S. Fixed Nitrogen Corporation, which was passed by the Senate recently, admits that there no longer is hope for the final approval of the bill at this session of Congress. Opposition to the measure in the House was sufficiently strong to prevent its being brought to a vote in the lower chamber. Senator Underwood remarked, however, that the proposal to keep the nitrate plants at Muscle Shoals in stand-by condition is untenable and that sooner or later Congress will be forced to make some disposition of them.

Senator Underwood was successful in his effort to obtain the adoption by the Senate of an amendment to the sundry civil bill appropriating $10,000,000 for continuing the work on the Wilson dam. It is regarded as probable that this item can be held in the bill, despite the fact that the House refused to amend the bill to that effect.

New Haven Section, A.C.S., Elects Officers

At the annual meeting held Jan. 28 at the Graduates' Club the New Haven Section of the American Chemical Society elected the following officers for the ensuing year: President, Dr. H. Hibbert; vice-president, Dr. M. C. Burt; treasurer, J. L. Christie; secretary, Dr. Blair Saxton; councillor, W. R. Hibbard.

At dinner the members gathered in Kent Laboratory when Dr. S. F. Acree, of Hahnemann Hospital, Rochester, N. Y., delivered a very interesting address on "The Measurement and Significance of Hydrogen Ion Concentration in Chemical and Biological Work." He exhibited his apparatus for determining hydrogen ion concentration, and illustrated his lecture by showing titration curves for pure acids, buffer solutions and extracts such as those from flour, cornmeal and chestnut bark. He pointed out various problems in which hydrogen ion concentration is an important factor. Among those mentioned were bacterial growth, tanning, inversion of sugar, electroplating, precipitation from water solution, plant growth and soil acidity, and the growth of chestnut blight and the acidity of the bark extract. He further brought out how titration curves may be analyzed back and the acids present in a solution identified. This might prove useful in the study of the decomposition products of such substances as the proteins.

Dr. Acree also showed samples of standardized sterile indicator and buffer tablets which have proved to be of great convenience, especially to bacteriologists.

Book Reviews

APPPLICATION OF DYESTUFFS. By *J. Merritt Matthews*, Ph.D. Pp. xvi + 768; 303 figures. New York: John Wiley & Sons, Inc., 1920. Price $10.

This volume is an outgrowth of the author's earlier book, "Laboratory Manual of Dyeing and Textile Chemistry." It has retained the text-book feature, but has been broadened in scope and detail. A feature of the book is the large number of illustrations of machines that find application in the treatment of the textile fiber from the raw material to the finished product. Emphasis is placed on the dyeing of textiles and particularly the processing of the most important fibers, wool, cotton and silk.

The general scheme of the book is first to study the action of various chemical agents on the fibers and methods of scouring and bleaching them preparatory to dyeing. The dyes are then classified from the standpoint of their application to the fibers. Each class is then presented in detail sufficient to explain the general methods of application and the chemistry underlying the process. No attempt is made to consider dyestuffs from their chemical classification. That dyestuffs are important to many industries that color their products is shown in the use of dyes for coloring of leather, paper, printing inks, etc.

One will find information on the equipping of a laboratory and methods of testing dyes for strength, etc. The history of dyeing, theory of dyeing, dyeing of mixtures of animal and vegetable fibers, methods of textile chemistry, tables of specific gravities and other information regarding the materials of the dyer and an extended bibliography round out the volume.

There is a wealth of general information presented, mention, at least, being made of almost every method of dyeing or related processes that are likely to be used. Only generalizations can be made, as each phase is capable of becoming a highly specialized one. Dyestuffs are individualistic in their properties, and methods of application must change as the materials that are being processed change. Practical contact must be had for a thorough understanding. The book, however, should prove valuable to all those interested in application of dyestuffs or related processes, especially in the textile industry. For the student there is a list of experiments at the end of the chapters that point out the main facts that need emphasis. ELMER C. BERTOLET.

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EMINENT CHEMISTS OF OUR TIME. By *Benjamin Harrow*, Ph.D. New York: D. Van Nostrand Co. Price $2.50.

Dr. Harrow, who is associate in physical chemistry in Columbia University, has written a book that was much needed. We need tags for our great men in chemistry. They have done important things, and the world should know them by name. But it doesn't. Their work is very arduous; it calls for such intense application that few of them are known in affairs. They do not grow rich, save in rarely exceptional cases, and therefore they do not build palaces or give social parties that are remembered—like the Bradley Martin ball of a generation ago.

In the present volume Dr. Harrow has with great diligence prepared monographs on the following eminent men: Sir William Henry Perkin, Mendeleef, Sir William Ramsay, Theodore W. Richards, van't Hoff, Arrhenius, Morrison, the Curies, Victor Meyer, Ira Remsen and Emil Fischer. At the end of each chapter there is a list of references from which he obtained his information.

As records the monographs are excellent, and the book is enriched with full-page likenesses of each of the subjects treated. It was written for the general public rather than for chemists alone, and while it would have made the work unwieldy if complete lists of the works of the various leaders were given, the author has emphasized the leading contributions of each.

Our only criticism is that the author has not studied his various subjects with such enthusiasm as to give a more intimate touch to his work. We know about the men after reading the several essays, but we do not feel that we know them. There are not many short, fat, tell-tale sentences such as that in regard to the Russian who, on meeting Sir William Ramsay, said, "I am Mendeleef!" That "I am" is significant and explains the difference between Mendeleef and Newlands, and why the former was indifferent as to whether other chemists laughed or cried over the Periodic Table, while the jeers of his fellow members of the Chemical Society of London caused poor Newlands to give it up in despair. We miss the abounding good fellowship of Sir William Ramsay, the subtle refinement and social grace of Theodore Richards, the flirtatious days of van't Hoff as a student, and the persistent flutter of young feminine hearts about him, the joy of companionship which Arrhenius bestows, or the amazing beauty of Victor Meyer as a young professor at Zurich with his singular resemblance to the Christ-face of the Renaissance painters.

These, however, are mere details. Dr. Harrow gives more important information, and the book is at once readable and is enlivened by a number of happy anecdotes. It "belongs" in every chemist's library. ELLWOOD HENDRICK.

Personal

W. E. BURKHARD, formerly chemical engineer with the Perth Amboy Chemical Works, is now chemical engineer with Clark, MacMullin & Riley of New York.

E. K. CHASE, assistant superintendent of the Pueblo plant of the American Smelting & Refining Co., is recovering from appendicitis and leaves for California soon to recuperate.

R. E. DEMMON has been transferred from the main office of the Stauffer Chemical Co. to the Houston, Tex., office, where he is general manager. The sulphur refinery of the company is at Freeport, Tex.

WALTER S. ERNST has recently resigned as chief chemist from the Ironton plant of the Alpha Portland Cement Co. to enter the University of Alabama as a student in the chemical engineering college.

A. E. MACARTHUR, formerly chemist at the Durango plant of the American Smelting & Refining Co., has been transferred to the Pueblo plant to organize and operate the salvage department.

O. E. RUHOFF, formerly chemical engineer for the French Battery & Carbon Co., Madison, Wis., has severed his connection with that company in order to associate himself with the Industrial Research Laboratories of Chicago.

Dr. JOHN E. SCHOTT has recently been appointed assistant professor of chemistry at Pennsylvania State College, State College, Pa.

HOMER STALEY, of the Metal & Thermit Corporation, is spending several weeks in Chicago working out problems at the plant of the company.

MAX SELTZER, who was formerly connected with the Research Laboratory of Applied Chemistry at the Massachusetts Institute of Technology, Cambridge, Mass., is now chemist for the Interstate Chemical Co., of Jersey City.

Dr. CHARLES WADSWORTH, who has recently become affiliated with the Grasselli Chemical Co., is carrying on some special research work at the Chicago plant.

M. M. WOOD is now employed as chief chemist by the Little Rock Picron Industrial Co., Little Rock, Ark., which purchased the picric acid plant built by the Government.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Feb. 14, 1921.

Inquiries of a miscellaneous nature kept the chemical market in an irregular condition during the past week. Business in general was interrupted now and then by intervals of dullness and it appeared that consumers were still doing more meditating than operating. This condition is the result of the acute downward revision of values and the fact that not enough confidence in the future has been restored to instill a more optimistic spirit in the purchasing of materials on a large scale. Compared with the beginning of the year, however, conditions seem more improved and activity shows some expansion. There is no doubt that business is due to become better, but it looks as though the increase will be along gradual lines. Reports of a general improvement were heard from some of the leading textile mills which are distinctly favorable factors for the chemical market. A steady increase in activity was noted from shoe and leather factories, and paper mills were disposing of their stocks at recently reduced prices. The soap industry has shown a somewhat irregular condition, but indications are more favorable than at the beginning of the year as far as activity is concerned.

Quite a satisfactory amount of small lot business was placed during the week. Some large inquiries were also noted in the market, but the wide differential in manufacturers' and second-hand prices had a restraining influence on the consummation of any big business. Several of the smaller chemicals were reduced in price. Such items as cobalt oxide, fluoride of soda, white granular sal ammoniac, prussiate of soda and cream of tartar have sold at lower prices on the spot market. The big items have shown a steadier tendency with the exception of bichromate of soda, which suffered from second-hand competition and closed with a loss of ½c. lb.

GENERAL CHEMICALS

Resale *bichromate of soda*, standard make, was offered at 8½c. per lb., with odd lot sales reported down to 8¼c. The tone of the market appeared rather easy under pressure of resale stock through second hands. Demand was quiet and confined mostly to small lots. Dealers quoted March shipments at 8¾c. per lb. Resale lots of *bisulphite of soda* were on the market at 5½c. per lb. against an inside figure of 6¼c., which was named by some producers. The demand cannot be termed active, although small lot sales for actual consuming wants were passing. General quotations for resale solid *caustic soda* remained at $3.85@$3.95 per 100 lb. Odd lots of standard material could be purchased at 5c. per 100 lb. below the general figure. Contracts were held firm by leading producers at $3.60 per 100 lb., basis 60 per cent, f.o.b. works for prompt and future shipments. Trading was not very lively, although a moderate exchange of carlots was reported among dealers. American *cyanide of soda* is holding steady under limited offerings. Leading producers quote the market at 29c. per lb. and it is doubtful if any small lots can be purchased under this price in any second-hand quarters. The French is quoted at 20c. per lb., while Cassell's English is held at 25c. Sellers of German quote the market at 21@23c. per lb. according to strength.

Spot prices of *nitrite of soda* have been subjected to considerable irregularity during the past week. Some of the largest dealers have advanced their price to 9c. per lb., while small lots on spot were obtainable all the way down to 6c. A moderate improvement from domestic consumers was reported. *Prussiate of soda* closed easy with sellers asking 16¼c. per lb. Forward shipments were offered at 15¼c. per lb. The demand was quiet in the final trading and a keen state of competition existed among dealers. Light *soda ash*, in barrels closed firm at 2¼c. per lb. ex-store N. Y. A fair inquiry was reported for this material in

cooperage, but the resale offerings were small. Single bags were quoted at $2.05 per 100 lb. Double bags were quiet and rather nominal at $2.20 per 100 lb. Contract prices remained firm at $1.72½ per 100 lb., basis 48 per cent, f.o.b. works.

While odd lots of domestic *caustic potash* are floating around the market at 14c. per lb. through second hands, there are sellers of 88-92 per cent KOH imported material at 9c. per lb. laid down in N. Y. The irregularity in price of late has dampened any large buying interest except for actual necessities. Large producers have not announced any new prices so far this year. Spot *oxalic acid* closed firm with 18c. lb. as an inside figure by second hands. In most quarters the market was quoted above this level and the extreme price range is up to 25c. per lb., according to brand and seller. Shipments from abroad were offered at 17½c. in some directions. Enough white granular, high-test *sal ammoniac* is being dumped into the open market to depress prices. There were sellers at the close of the week at 7¾c. per lb. The inquiry for this material has not been active of late and there is a keen state of competition existing among holders of imported material.

Coal-Tar Products

Appearances during the week in the coal-tar products markets were mostly of an encouraging nature and while here and there an easy tendency was noted, the bulk of the various factors held views that reflected firmness. Activity varied from day to day and during the close of the week the interest of buyers slacked off somewhat and offerings did not attract the same attention. Buyers, however, were in close touch with the market and were ready to pick up any real bargains.

The *naphthalene* season is at hand and speculative buying of the off grades was noted in some directions. The pure white flakes were held firm and the best offering that could be located was at 8½c. per lb. Producers continued to quote 9@10c. per lb. on flakes and 11c. on balls. During the early part of the week *aniline* was fairly steady at 21@26c. per lb., although a lot here and there was offered at 20c., while at the close a seller of a round lot was calling for bids. Supplies of *dimethylaniline*, *beta naphthol*, *para nitraniline* and *para toluidine* were easy and shading in second hands was possible.

Producers of *alpha naphthalamine* continued to quote steady at 40@45c. per lb. Supplies in second hands are reported available in fair volume and with the demand light prices were heard at 38@40c. per lb. Trading in *dinitro chlorbenzene* is reported as quiet with only a light routine movement. Supplies are easy on a basis of 25@30c. per lb., while in second hands shading on firm business is possible. The market in *salicylic acid* is not very active at this time and only small lots are moving into consuming channels. There has been no recent change in prices, which range from 25@30c. per lb. Trading in the market for *para toluidine* is dull with most factors taking care of a moderate routine call which is about sufficient to meet consumers' immediate needs. Prices vary somewhat, depending on sellers, and range from $1.40@$1.70 per lb.

Rubber—Waxes

The crude rubber market was easier during the past week, but toward the close a reaction was noted with higher prices named. Spot ribbed smoked sheets opened at 18¾c. per lb. but declined to 17¾c., the lowest of the week. At the close, however, a firmer tone developed and prices advanced to 18c. with a few small sales recorded at 17½@17¾c. per lb. Sales of first latex occurred at 19½c. per lb., while sellers were asking 19¾c. March ribbed advanced to 18½c. April, May, June was quoted at 21c. by holders and buyers at 20½c. per lb., but as far as could be ascertained no business was done. For July-December, sellers named 26c. per lb. and buyers 25c. Trading in general was of a small volume, as consuming manufacturers continue to be practically out of the market.

Importers of African and Brazilian *beeswax* reported market conditions as unchanged with prices on a fairly steady basis. African crude wax in carlots was offered at 17½@18c. per lb. for immediate shipment. Brazilian crude wax was held at prices ranging from 24@26c. per lb. Trading in refined was along routine lines only and prices were more or less nominal. A moderate buying interest was noted for the lower grades of *carnauba wax* and prices closed for the week practically unchanged both in prompt and forward business. The high grades on spot continued in light supply. No. 2 North Country was quoted at 33@35c. per lb., while No. 3 was unchanged at 18@19c. per lb. Spot offerings of *Japan wax* were moderate and prices ruled steady ranging from 19@20c. per lb. Shipment prices showed little change and the situation was regarded as favoring sellers so far as the near future was concerned. Offerings of both crude and refined *paraffine wax* continued on a liberal scale and prices throughout the week were unsettled, the undertone being easy. Export shipments against old contracts were fairly large but new business was reported as dull in nearly all directions. Crude wax, 124-126 deg. melting point, was available in a large way at 4c. per lb., with intimations that this figure could be shaded on a firm bid. Refined, 128-130 deg. melting point, was available at 6½c. per lb.

The Iron and Steel Market

Pittsburgh, Pa., Feb. 11, 1921.

The finished steel market has suddenly started to break. There is not the gradual subsidence that was expected in most quarters, but rather a sharp drop, whereby in a very short time a level will be found that will prove relatively stable, at least until costs can be reduced.

It will be recalled that the steel market of the independents dropped to the Steel Corporation or Industrial Board level in the closing weeks of the old year, bars, shapes and plates showing their drop the day after Thanksgiving Day. A common expectation then was that the independents would promptly begin shading the regular prices by small amounts, whereby in time the market might slowly subside. This expectation was not borne out. Many independents did not cut at all, while others who were disposed to make slight concessions found there was scarcely any business to be obtained that way.

Thus a situation was presented. The Midvale Steel & Ordnance Co. decided to canvass the trade for orders, offering substantial concessions. The canvass occupied a few days, with the other independents watching. Apparently their philosophy at the time was that if the cutting produced much business they would participate and if it did not they would remain aloof. It did not produce much business. Then, it appears, the other independents altered their viewpoint and concluded that the test showed that eventually very substantial reductions would have to occur and that they might as well meet this situation at once. Accordingly a large number of independents yesterday became willing to make substantial reductions, the amount to be determined by the tonnage obtainable and the possibility of avoiding loss either against previous costs or such costs as could be developed by further economy.

Finished Steel Market Declining Rapidly

The finished steel market has accordingly been declining rather sharply in the past couple of days, and there are no prices that are sufficiently fixed to be quoted as the market even for a day. For illustration, merchant steel bars, which had been 2.35c., sold in some fair sized lots at 2.25c., then in a small lot at 2.20c., with possibly some sales at 2.10c., while the latest is that one mill has adopted 2c., not quoting the price openly but being ready to take any order of reasonable size and fair specifications at that figure. In structural shapes 2.25c. has been named, or $4 a ton decline, without any business of importance developing. Plates had been selling at times for weeks at 2.50c., against the Industrial Board or Steel Corporation price of 2.65c., while in the past few days 2.40c. has been done and quite probably less.

It is of no moment just where the market stands at the present writing. Enough is known to permit a guess to be hazarded as to the approximate level the heavy rolled products will develop in the present movement. The level is about 2c. Shapes will probably be about $2 a ton above

bars, and plates may not be as much above bars. Before the war plates and shapes averaged quite closely $2 a ton above bars, but with the large plate-making capacity now in existence a smaller spread may obtain. Until now plates have preserved much of the spread above bars and shapes that the war-time regulation furnished as an incentive to plate manufacture, the war control prices being 2.90c. for bars, 3c. for shapes and 3.25c. for plates.

Concessions in Sheets

Concessions thus far announced in sheets represent about $3 a ton, outside of prices made by some mills at a distance from Pittsburgh, representing concession of part of the freight advantage. As the system of Pittsburgh basing has not been expected to stand in a period of active competition, such special prices cannot properly be figured back to Pittsburgh and the claim made that the Pittsburgh price itself is cut by the amount shown. In wire products it is not known that more than one producer has departed from regular prices, it being stated that one producer east of Pittsburgh is naming $3.10 on nails, against the regular price of $3.25.

No Reduction by Steel Corporation

The United States Steel Corporation has made a formal announcement that it will not reduce prices or wages, but it would be impossible to name a time for which such a statement would hold good. Such curious views have been spread as to business and economics that the statement may be misinterpreted in some quarters. Conditions in the steel industry are changing and the Steel Corporation will certainly meet at the proper time any important changes that occur. For several weeks, until recently, the corporation operated at about 92 per cent of capacity. In the past fortnight its operations have been sensibly declining, being now probably at about 85 per cent. Further decreases are to be expected. If the operation decreased to 60 per cent, the corporation management would undoubtedly consider the whole subject of prices and wages afresh and might then decide to reduce both.

The Steel Corporation's unfilled obligations decreased by 574,958 tons in January, this being 300,000 tons less than the December decrease. Shipments were slightly less, while actual bookings were hardly increased. A month ago it was commonly reported that toward the close of December the corporation went over its books and carefully cut out all doubtful tonnages, and apparently there were no cancellations of consequence in January. This would account for the divergence. Stated in estimated percentages of the corporation's capacity for a month, the matter may be put thus: December shipments, 94 per cent; unfilled tonnage decrease, 64 per cent; net bookings, 30 per cent, made up of actual bookings of 50 per cent and cancellations of 20 per cent; January shipments, 90 per cent; unfilled tonnage decrease, 44 per cent; bookings, 44 per cent.

Pig Iron Prices

Foundry pig iron has declined another dollar a ton, to $28 valley, on a rather small turnover. Bessemer and basic are unquotable. Regular producers state that they have had no occasion, on account of lack of inquiry, to depart from their former quotations of $32 for bessemer and $30 for basic, but would welcome the opportunity to do so. It is understood that some odd lots of basic could be picked up from steel interests that do not usually sell in the market at well under $30. On account of the break in steel prices now in progress and the further decline in foundry iron, it is probable that producers will of their own accord announce new prices, which may be in the neighborhood of $28.50 for bessemer and $27 for basic. Such prices would probably represent a loss on the basis of recent costs, but efforts are being made to reduce costs and some of the Connellsville coke operators are anxious to co-operate in such work.

Production of steel ingots in January was at the rate of about 90 per cent of capacity by the Steel Corporation and 28 per cent by the independents. From the present outlook February production may be 80 or 85 per cent by the corporation and about 25 per cent by the independents.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.		$0.55 – $0.60
Acetone	lb.	$0.13 – $0.13½	13½ – .14
Acid, acetic, 28 per cent	100 lbs.	3.00 – 3.25	3.50 – 3.75
Acetic, 56 per cent	100 lbs.	6.00 – 6.25	6.50 – 6.75
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	10.50 – 11.00	11.25 – 11.50
Boric, crystals	lb.	.14½ – .15	15½ – .16
Boric, powder	lb.	.15½ – 16½	17 – 18
Citric	lb.		46 – .48
Hydrochloric	100 lb.	1.60 – 1.75	1.85 – 2.25
Hydrofluoric, 52 per cent	lb.	.15 – .16	.16½ – .18
Lactic, 44 per cent tech	lb.	.10 – .11	.11½ – .12
Lactic, 22 per cent tech	lb.	.04½ – 05½	06 – .07
Molybdic, C. P.	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)			
Nitric, 40 deg	lb.	.07 – 07½	.08 – .08¼
Nitric, 42 deg	lb.	.08½ – 09	09½ – 10
Oxalic, crystals	lb.	.18 – 18½	18½ – .19
Phosphoric, ortho, 50 per cent solution	lb.	.15 – 15½	16 – .16½
Picric	lb.	.30 – 32	35 – .40
Pyrogallic, resublimed	lb.		2.30 – 2.40
Sulphuric, 60 deg., tank cars	ton		
Sulphuric, 60 deg., drums	ton		14.00 – 15.00
Sulphuric, 66 deg., tank cars	ton	18.00 – 19.00	
Sulphuric, 66 deg., drums	ton	21.00 – 22.00	22.50 – 23.00
Sulphuric, 66 deg., carboys	ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	23.00 – 24.00	
Sulphuric, fuming, 20 per cent (oleum) drums	ton	25.00 – 26.00	26.50 – 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35.00	40.00 –
Tannic, U. S. P.	lb.		1.15 – 1.25
Tannic (tech.)	lb.	.45 – .47	.48 – .50
Tartaric, crystals	lb.		.33 – .35
Tungstic, per lb. of WO	lb.		1.00 – 1.20
Alcohol, Ethyl	gal.		5.10 – 5.50
Alcohol, Methyl (see methanol)			
Alcohol, denatured, 188 proof	gal.		.65 – .67
Alcohol, denatured, 190 proof	gal.		.68 – .70
Alum, ammonia lump	lb.	.04½ – 04¾	.05 – .05½
Alum, potash lump	lb.	.05½ – 06	.06½ – .07
Alum, chrome lump	lb.	.13 – 13½	14 – .14½
Aluminum sulphate, commercial	lb.	.02¼ – 02½	02½ – .03
Aluminum sulphate, iron free	lb.	.03 – 03¼	03¼ – .03¼
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07 – 07½	07¾ – .08
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .32	.33 – .35
Ammonium carbonate, powder	lb.	.11½ – 11¾	.12 – .12½
Ammonium chloride, granular (white salamoniac) (nominal)	lb.	.07½ – 07¾	.08 – .08¼
Ammonium chloride, granular (gray salammoniac)	lb.	.09 – 09½	.09½ – 10
Ammonium nitrate	lb.	.09 – 09½	10 – 10½
Ammonium sulphate	100 lb.	3.30 – 3.40	3.50 – 3.75
Amylacetate	gal.		4.25 – 4.50
Amylacetate tech	gal.		3.50 – 3.75
Arsenic oxide, (white arsenic)	lb.	.10 – 10½	10¾ – 11
Arsenic, sulphide, powdered (red arsenic)	lb.	.14 – 14½	15 – 15½
Barium chloride	ton	65.00 – 70.00	75.00 – 80.00
Barium dioxide (peroxide)	lb.	.24 – 25	26 – 27
Barium nitrate	lb.	.10 – 10½	10½ – .11
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ – 05	05½ – 06
Bleaching powder (see calc. hypochlorite)			
Blue vitriol (see copper sulphate)			
Borax (see sodium borate)			
Brimstone (see sulphur, roll)			
Bromine	lb.	.50 – 52	.54 – .56
Calcium acetate	100 lbs.	2.00 – 2.05	
Calcium carbide	lb.	.04 – 04¼	04½ – 05
Calcium chloride, fused, lump	ton	27.00 – 29.00	30.00 – 32.00
Calcium chloride, granulated	lb.	.01½ – 02	02½ – 02½
Calcium hypochlorite (bleach'g powder)	lb.	.02½ – .03	03½ – 03½
Calcium peroxide	lb.		1.00 – 1.10
Calcium phosphate, monobasic	lb.		.15 – .16
Camphor	lb.		.80 – .85
Carbon bisulphide	lb.	.08 – .08½	.09 – .09½
Carbon tetrachloride, drums	lb.	.11½ – .11¾	.12 – .12½
Carbonyl chloride (phosgene)	lb.		.75 – 1.00
Caustic potash (see potassium hydroxide)			
Caustic soda (see sodium hydroxide)			
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 – .09½	.10 – .10½
Chloroform	lb.		.43 – .50
Cobalt oxide	lb.		3.00 – 3.10
Copperas (see iron sulphate)			
Copper carbonate, green precipitate	lb.	.22 – 22½	.24 – .25
Copper cyanide	lb.		.50 – .60
Copper sulphate, crystals	lb.	.06½ – .06½	06½ – .07½
Cream of tartar (see potassium bitartrate)			
Epsom salt (see magnesium sulphate)			
Ethyl Acetate Com. 85%	gal.		1.05 – 1.10
Ethyl Acetate pure (acetic ether 98% to 100%)			
Formaldehyde, 40 per cent	lb.	.17½ – 17½	.18 – .18½
Fusel oil, ref.	gal.		3.50 – 3.60
Fusel oil, crude	gal.		2.75 – 3.00
Glauber's salt (see sodium sulphate)			
Glycerine, C. P. drums extra	lb.		.20 – .21
Iodine, resublimed	lb.		3.85 – 4.00
Iron oxide, red	lb.		.10 – .20
Iron sulphate (copperas)	100 lb.	1.25 – 1.50	1.75 – 2.00
Lead acetate, normal	lb.		14½ – .16
Lead arsenate (paste)	lb.	.11 – .12	12½ – .13
Lead nitrate	lb.		.15 – .20
Litharge	lb.	.08½ – .09	09½ – .10
Lithium carbonate	lb.		1.25 –
Magnesium carbonate, technical	lb.	.10½ – .11	.11½ – .12
Magnesium sulphate, U. S. P.	100 lb.	2.50 – 3.00	
Magnesium sulphate, commercial	100 lb.		1.50 – 1.75
Methanol, 95%	gal.		1.28 – 1.30
Methanol, pure	gal.		1.60 – 1.65
Nickel salt, double	lb.		.12 – .12½
Nickel salt, single	lb.		.13 – .13½
Phosgene (see carbonyl chloride)			
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.		.35 – .37
Potassium bichromate	lb.	.14½ – .14¾	.15 – .15½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$ – $	$0.30 – $0.35
Potassium bromide, granular	lb.	–	.20 – .40
Potassium carbonate, U. S. P.	lb.	.35 – .40	.45 – .50
Potassium carbonate, crude	lb.	.08 – .08½	.09 – .10
Potassium chlorate, crystals	lb.	.08 – .10	.11 – .18
Potassium cyanide	lb.	–	.65 – .70
Potassium hydroxide (caustic potash)	lb.	.14 – .14½	.15 – .16
Potassium muriate	ton	75.00 – 80.00	–
Potassium iodide	lb.	–	3.00 – 3.20
Potassium nitrate	lb.	.09½ – .10	.10½ – .12½
Potassium permanganate	lb.	.48 – .50	.52 – .60
Potassium prussiate, red	lb.	.50 – .52	.53 – .55
Potassium prussiate, yellow	lb.	.26 – .26½	.27 – .27½
Potassium sulphate (powdered)	per unit	–	– 2.25
Rochelle salts (see sodium potas. tartrate)			
Salammoniac (see ammonium chloride)			
Sal soda (see sodium carbonate)			
Salt cake	ton	–	32.00 – 33.00
Silver cyanide	oz.	–	1.25 –
Silver nitrate	oz.	–	.43½ – .44
Soda ash, light	100 lb.	2.00 – 2.10	2.15 – 2.25
Soda ash, dense	100 lb.	2.15 – 2.25	2.30 – 2.40
Sodium acetate	lb.	.05½ – .05¾	.06 – .06½
Sodium bicarbonate	100 lb.	2.50 – 2.75	3.00 – 3.25
Sodium bichromate	lb.	.08½ – .08¾	.08¾ – .09
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 11.00
Sodium bisulphite powdered, U.S.P.	lb.	.05½ – .05¾	.06 – .06½
Sodium borate (borax)	lb.	.08½ – .08¾	.08¾ – .09
Sodium carbonate (sal soda)	100 lb.	2.00 – 2.25	2.50 – 2.75
Sodium chlorate	lb.	.10 – .10½	.10¾ – .11
Sodium cyanide, 96-98 per cent	lb.	.20 – .21	.22 – .28
Sodium fluoride	lb.	.13½ – .14	.14½ – .15
Sodium hydroxide (caustic soda)	100 lb.	3.85 – 3.90	3.95 – 4.25
Sodium hyposulphite	lb.	–	.03¾ – .04
Sodium nitrate		2.85 –	3.00 –
Sodium nitrite	lb.	.06 – .06½	.06½ – .07
Sodium peroxide, powdered	lb.	.30 – .31	.32 – .34
Sodium phosphate, dibasic	lb.	.03½ – .04½	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	–	.29 – .31
Sodium prussiate, yellow	lb.	.16 – .16¼	.16½ – .17
Sodium silicate, solution (40 deg.)	lb.	1.10 – 1.15	1.20 – 1.40
Sodium silicate, solution (60 deg.)	lb.	.02¼ – .03	.03¼ – .03½
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.75 – 2.00	2.25 – 2.50
Sodium sulphide, crystal, 60-62 per cent (cone.)	lb.	.05 – .05½	.05½ – .06
Sodium sulphite, crystals	lb.	.04 – .04¼	.04½ – .05
Strontium nitrate, powdered	lb.	.17½ – .18	.18¼ – .18½
Sulphur chloride, red	lb.	.07 – .07¼	.07½ – .08
Sulphur, crude	ton	16.00 – 20.00	–
Sulphur dioxide, liquid, cylinders	lb.	.08 – .08½	.08½ – .09
Sulphur (sublimed), flour	100 lb.	–	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	–	2.00 – 2.75
Tin bichloride, 50 per cent	lb.	.18 – .19	–
Tin oxide	lb.	–	.45 – .47
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran.	lb.	.11½ – .12	.12½ – .13
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.12 – .13	.13½ – .14
Zinc oxide, XX	lb.	.08½ – .09	.09½ – .11
Zinc sulphate	lb.	.03½ – .03¾	.04 – .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.10 — $1.15
Alpha-naphthol, refined	lb.	1.45 — 1.50
Alpha-naphthylamine	lb.	.38 — .40
Aniline oil, drums extra	lb.	.21 — .27
Aniline salts	lb.	.27 — .30
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.00 — 2.10
Benzidine, base	lb.	1.00 — 1.10
Benzidine sulphate	lb	.80 — .90
Benzoic acid, U.S.P.	lb.	.70 — .75
Benzoate of soda, U.S.P.	lb.	.70 — .80
Benzene, pure, water-white, in drums (100 gal.)	gal.	.30 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.28 — .32
Benzyl chloride, 95-97%, refined	lb.	.30 — .35
Benzyl chloride, tech.	lb.	.25 — .30
Beta-naphthol benzoate	lb.	3.50 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech.	lb.	.30 — .35
Beta-naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums	gal.	.95 — 1.00
Cresylic acid, 95-97%, dark, in drums	gal.	.90 — .95
Cresylic acid, 50%, first quality, drums	gal.	.60 — .65
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.25 — 1.30
Dimethylaniline	lb.	.55 — .65
Dinitrobenzene	lb.	.30 — .32
Dinitroclorbenzene	lb.	.25 — .30
Dinitronaphthalene	lb.	.33 — .35
Dinitrophenol	lb.	.40 — .45
Dinitrotoluene	lb.	.25 — .30
Dip oil, 25%, tar acids, car lots, in drums	gal.	.37½ — .40
Diphenylamine	lb.	.60 — .70
H-acid	lb.	1.30 — 1.50
Meta-phenylenediamine	lb.	1.25 — 1.30
Monochlorbenzene	lb.	.14 — .16
Monoethylaniline	lb.	1.80 — 2.00
Naphthalene crushed, in bbls. (250 lb.)	lb.	.07¼ — .08
Naphthalene, flake	lb.	.08 — .08½
Naphthalene, balls	lb.	.08 — .08½
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.18 — .25
Ortho-amidophenol	lb.	3.20 — 3.75
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.20 — .24
Ortho-toluidine	lb.	.25 — .30
Para-amidophenol, base	lb.	1.90 — 2.00
Para-amidophenol, HCl	lb.	2.10 — 2.20
Para-dichlorbenzene	lb.	.15 — .25
Paranitroaniline	lb.	.85 — .90
Para-nitrotoluene	lb.	.90 — 1.05
Para-phenylenediamine	lb.	1.80 — 2.20
Para-toluidine	lb.	1.30 — 1.60
Phthalic anhydride	lb.	.55 — .60
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.10 — .12
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	1.85 — 2.00
Resorcinol, pure	lb.	2.50 — 2.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.23 — .25
Salicylic acid, U. S. P.	lb.	.27 — .30
Salol	lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.28 — .32
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.16 — .18
Sulphanilic acid, crude	lb.	.30 — .35
Tolidine	lb.	1.35 — 1.45
Toluidine, mixed	lb.	.40 — .45
Toluene, in tank cars	gal.	.28 — .32
Toluene, in drums	gal.	.30 — .35
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.42 — .45
Xylene, pure, in tank cars	gal.	.45 —
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 —

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.24 — $0.26
Beeswax, refined, light	lb.	.27 — .28
Beeswax, white pure	lb.	.40 — .45
Carnauba, No. 1	lb.	.75 — .77
Carnauba, No. 2, North Country	lb.	.33 — .35
Carnauba, No. 3, North Country	lb.	.18 — .19
Japan	lb.	.19 — .20
Montan, crude	lb.	.07 — .08
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04½ — .04¾
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.04 — .04½
Paraffine waxes, refined, 118-120 m.p.	lb.	.05½ —
Paraffine waxes, refined, 125 m.p.	lb.	.06½ —
Paraffine waxes, refined, 128-130 m.p.	lb.	.06½ —
Paraffine waxes, refined, 133-135 m.p.	lb.	.07 — .07½
Paraffine waxes, refined, 135-137 m.p.	lb.	.09½ —
Stearic acid, single pressed	lb.	.12½ —
Stearic acid, double pressed	lb.	.13½ —
Stearic acid, triple pressed	lb.	.14 —

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr., 0.930-0.940	gal.	$1.70
Pine oil, pure, dest. dist.	gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.	.37
Pinewood creosote, ref.	gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl.	280 lb.	$8.00	—
Rosin E-I	280 lb.	8.00	—
Rosin K-N	280 lb.	8.00	—
Rosin W. G.-W. W.	280 lb.	8.25	—
Wood rosin, bbl.	280 lb.	8.50	—
Spirits of turpentine	gal.	.60	—
Wood turpentine, steam dist.	gal.	.58	—
Wood turpentine, dest. dist.	gal.	.57	—
Pine tar pitch, bbl.	200 lb.		— 8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.		— 15.00
Retort tar, bbl.	500 lb.	15.00	— 15.50
Rosin oil, first run	gal.	.50	—
Rosin oil, second run	gal.	.52	—
Rosin oil, third run	gal.	.60	—

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.41
70-72 deg., steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para—Upriver fine	lb.	$0.18½ —	$0.19
Upriver coarse	lb.	.14 —	.14½
Upriver caucho ball	lb.	.14½ —	.14¾
Plantation—First latex crepe	lb.	.19½ —	
Ribbed smoked sheets	lb.	.18 —	
Brown crepe, thin, clean	lb.	.18 —	
Amber crepe No. 1	lb.	.20 —	

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.09¼ —	$0.10
Castor oil, AA, in bbls.	lb.	.11 —	.11½
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.08½ —	.08¾
Cocoanut oil, Ceylon grade, in bbls.	lb.	.11¾ —	.12¼
Cocoanut oil, Cochin grade, in bbls.	lb.	.12¼ —	.12½
Corn oil, crude, in bbls.	lb.	.08¾ —	.09
Cottonseed oil, crude (f. o. b. mill)	lb.	.05½ —	.06
Cottonseed oil, summer yellow	lb.	.08½ —	.08¾
Cottonseed oil, winter yellow	lb.	.09 —	.09¼
Linseed oil, raw, car lots (domestic)	gal.	.68 —	.69
Linseed oil, raw, tank cars (domestic)	gal.	.61 —	
Linseed oil, boiled, car lots (domestic)	gal.	.70 —	.71

Olive oil, commercial	gal.	$2.00 —	$2.40
Palm, Lagos	lb.	.07½ —	.07¾
Palm, Niger	lb.	.07 —	.07½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.06¾ —	.07
Peanut oil, refined, in bbls	lb.	.13 —	.13½
Rapeseed oil, refined in bbls	gal.	1.10 —	1.15
Rapeseed oil, blown, in bbls	gal.	1.20 —	1.25
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.08 —	.08½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.05 —	....
FISH			
Light pressed menhaden	gal.	$0.46 —	$0.48
Yellow bleached menhaden	gal.	.48 —	.50
White bleached menhaden	gal.	.50 —	.52
Blown menhaden	gal.	.85 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00 —	30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00 —	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek	net ton	10.00 —	12.00
Barytes, floated, f.o.b. St. Louis	net ton	26.50 —	28.00
Barytes, crude, first grade, Missouri	net ton	10.00 —	.....
Blanc fixe, dry	lb.	.05 —	.05½
Blanc fixe, pulp	net ton	50.00 —	60.00
Casein	lb.	.14 —	.18
Chalk, domestic, extra light	lb.	.05 —	.06
Chalk, domestic, light	lb.	.04½ —	.05½
Chalk, domestic, heavy	lb.	.04 —	.05
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.05 —	.06
Chalk, English, dense	lb.	.04½ —	.05
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	8.00 —	10.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	12.00 —	15.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	18.00 —	22.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	15.00 —	40.00
China clay (kaolin), imported, lump	net ton	23.00 —	25.00
China clay (kaolin), imported, powdered	net ton	30.00 —	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8.00 —	14.00
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00 —	30.00
Fullers earth, f.o.b. Mines	net ton	16.00 —	17.00
Fullers earth, granular, f.o.b. Fla	net ton	25.00 —	.....
Fullers earth, powdered, f.o.b. Fla	net ton	18.00 —	.....
Fullers earth, imported, powdered	net ton	35.00 —	40.00
Graphite, crucible, 90% carbon, Ashland, Ala	lb.	..... —	.09
Graphite, crucible, 85% carbon, Ashland, Ala	lb.	.07 —	.09
Graphite, higher lubricating grades	lb.	.11 —	.40
Pumice stone, imported, lump	lb.	.04 —	.50
Pumice stone, domestic lump	lb.	.05 —	.05½
Pumice stone, ground	lb.	.06 —	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	..... —	10.00
Quartz (acid tower) 1¼@2 in., f.o.b. Baltimore	net ton	..... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	..... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	.65 —	.....
Shellac, orange superfine	lb.	.70 —	.....
Shellac, A. C. garnet	lb.	.57 —	.....
Shellac, T. N.	lb.	.55 —	.....
Soapstone	ton	12.00 —	15.00
Sodium chloride	long ton	..... —	17.00
Talc, paper-making grades, f.o.b. Vermont	ton	12.00 —	22.00
Talc, roofing grades, f.o.b. Vermont	ton	9.50 —	15.00
Talc, rubber grades, f.o.b. Vermont	ton	12.00 —	18.00
Talc, powdered, Southern, f.o.b. cars	ton	12.00 —	15.00
Talc, imported	ton	40.00 —	50.00
Talc, California talcum powder grade	ton	20.00 —	45.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	1,000	160
Chrome brick, f.o.b. Eastern shipping points	net ton	80–100
Chrome cement, 40–45% Cr_2O_3	net ton	45– 50
Chrome cement, 40–45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	....– 55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	55– 60
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45– 50
Magnesite brick, 9-in. straight	net ton	100
Magnesite brick, 9-in. arches, wedges and keys	net ton	105
Magnesite brick, soaps and splits	net ton	120
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	65– 70
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	56– 61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	50– 60

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$225.00
Ferrochrome per lb. of Cr. contained, 6–8% carbon, carlots	lb.	.16 —	...
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.16 —	.17
Ferromanganese, 76-80% Mn, domestic	gross ton	95.00 —	100.00
Ferromanganese, 76-80% Mn, English	gross ton	95.00 —	100.00
Spiegeleisen, 18-22% Mn	gross ton	38.00 —	40.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.00 —	2.50
Ferrosilicon, 10-15%	gross ton	50.00 —	55.00
Ferrosilicon, 50%	gross ton	78.00 —	80.00
Ferrosilicon, 75%	gross ton	140.00 —	145.00
Ferrotungsten, 70-80% per lb. of contained W	lb.	.55 —	.60
Ferrouranium, 35-50% of U, per lb. of U content	lb.	7.00 —	.....
Ferrovanadium, 30-40% per lb. of contained V	lb.	5.00 —	5.25

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content, less than 2% Fe_2O_3, up to 20% silica, not more than H 4% moisture	gross ton	$10.00 —	$11.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.55 —	.60
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	unit	.50 —	.55
Coke, foundry, f.o.b. ovens	net ton	6.50 —	7.00
Coke, furnace, f.o.b. ovens	net ton	5.00 —	5.25
Coke, petroleum, refinery, Atlantic seaboard	net ton	11.50 —	12.00
Fluorspar, lump, f.o.b. Heahden, New Mexico	net ton	17.50 —	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	22.50 —	25.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01¼ —	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.35 —	.40
Manganese ore, chemical (MnO_2)	gross ton	60.00 —	65.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.55 —	.60
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	30.00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.....
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.16½ —	.....
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	.12 —	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	.....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	3.00 —	3.25
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	3.00 —	3.25
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.50 —	2.50
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.50 —	.....
Zircon, washed, iron free	lb.	.03 —	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.75
Aluminum, 98 to 99 per cent	28.3@28.5
Antimony, wholesale lots, Chinese and Japanese	5.25
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	45.00
Monel metal, spot and blocks	35
Monel metal ingots	38
Monel metal, sheet bars	40
Tin, 5-ton lots	32.00
Lead, New York, spot	4.60
Lead, E. St. Louis, spot	4.10
Zinc, spot, New York	6.00
Zinc, spot, E. St. Louis	5.65

OTHER METALS

Silver (commercial)	oz.	$0.66½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.25@2.35
Cobalt	lb.	4.50
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	70.00
Iridium	oz.	325.00
Palladium	oz.	65.00@70.00
Mercury	75 lb.	50.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	21.00
Copper bottoms	33.00
Copper rods	28.00
High brass wire and sheets	18.75
High brass rods	16.75
Low brass wire and sheets	27.50
Low brass rods	18.50
Brazed brass tubing	35.25
Brazed bronze tubing	40.50
Seamless copper tubing	25.00
Seamless high brass tubing	24.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	11.50	18.50	10.00	10.50
Copper, heavy and wire	11.00	16.50	9.50	9.50
Copper, light and bottoms	9.00	14.50	9.00	8.50
Lead, heavy	4.00	7.25	4.00	4.00
Lead, tea	3.00	5.25	3.00	3.00
Brass, heavy	7.00	9.50	7.00	10.00
Brass, light	5.50	8.00	5.00	5.50
No. 1 yellow brass turnings	6.00	9.50	5.50	6.00
Zinc	4.00	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	*Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$3.73	$3.80	$3.47	$3.58	$3.37	$3.58	$3.47
Soft steel bars	3.93	3.70	3.52	3.34	3.27	3.48	3.52
Soft steel bar shapes	3.93	3.70	3.52	3.48	3.27	3.48	3.52
Soft steel bands	4.33	4.65	4.22	6.25	.....	.....	.....
Plates, ¼ to 1 in. thick	3.93	4.00	3.67	3.78	3.57	3.78	3.67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Amer. Cement Tile Mfg. Co., 509 Brown Marx Bldg., had plans prepared for the construction of a 60-200-ft. plant. L. W. Barner, Southern mgr.

BIRMINGHAM—J. E. Brow, comn., had plans prepared for the construction of a 1-story bath house and water-sterlizing plant on Ave. I and 29th St. Estimated cost, $45,000. J. Kendrick, Birmingham, engr.

California

STOCKTON—A. L. Banks, city clk., receives bids until March 8 for the construction of the south sewage disposal works, including chlorination equipment, settling tank, sludge beds, etc. W. B. Hogan, city engr.

Illinois

CHICAGO — W. G. Uffendel, archt., 39 South State St., will soon award contract for the construction of a 2-story, 116x118-ft. engraving factory on Fullerton and Racine Aves., for J. B. Wiggins, 1104 South Wabash Ave. Estimated cost, $75,000.

Iowa

DUBUQUE — The Bd. Educ. is having plans prepared for the construction of a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, $550,000. J. W. Royer, Urbana, Ill., archt.

GILMAN—The Bd. Educ. receives b'ds March 4 for the construction of a 2-story, 60x100-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $110,000. Keffer & Jones, 204 Masonic Temple, Des Moines, archts.

SHELLSBURG—The Bd. Educ. receives bids until March 11 for the construction of a 3-story, 80x110-ft. grade and high school. A chemical laboratory will be installed in same. Estimated cost, $140,000. A. K. Rife, secy. J. G. Ralston, 709 L. & J. Bldg., Waterloo, archt. Noted Nov. 17.

Michigan

PLAINWELL—The Bd. Educ. is having plans prepared for the construction of a 2-story, 100x196-ft. high school. A chemical laboratory will be installed in same. About $175,000. E. S. Batteson, Kalamazoo, archt.

Minnesota

CLOQUET — R. C. Hornby and R. M. Weyerhaeuser, representing owner, plan the construction of a mill to manufacture wallboard from saw mill waste near the Northern Lumber Co. Estimated cost, $250,000.

HACKENSACK — Bd. Educ., c/o F. R. Ross, Walker, receives bids until March 4 for the construction of a 2-story, 95x102-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $75,000. Liebenberg, Kaplan & Martin, 615 McKnight Bldg., Minneapolis, archts. Noted Dec. 29.

Missouri

COLUMBIA — City plans to construct sewage disposal plant, Imhoff tanks and sprinkling filters. Estimated cost, $177,000.

ST. LOUIS—L. Haeger, archt., 3844 Utah Pl., will soon award contract for the construction of a 1-story, 50x100-ft. foundry, for The Chester Iron & Fdry. Co., 7000 Vulcan St. Estimated cost, $30,000. E. A. Linnis, secy.

New Jersey

NEWARK—Barrison & Blase, South St., receives bids Feb. 21 for the construction of a 2-story brick and concrete factory on Governor St. and Marion Pl. About $75,000. F. Grad, 245 Springfield Ave., engr.

New York

BROOKLYN—Burley Welding Works, 22 Kosciusko St., will build a 3-story addition to its factory. Estimated cost, $50,000. E. M. Adelshon, 1778 Pitkin Ave., engr.

VICTOR — The Victor Plaster Co., recently incorporated to mine gypsum, plans to expend $140,000 for buildings and equipment. C. A. Huber, 51 Monroe Ave., Rochester, pres.

Ohio

CLEVELAND — Electric Steel & Forge Co., c/o J. H. Foster, pres., 6600 Grant Ave., plans to construct a 1-story steel rolling mill. Estimated cost, $200,000. J. H. Herron & Co., 1360 West 3d St., archts. and engrs.

COLUMBUS—The Ironclay Brick Co., 64 Ruggery Bldg., has awarded the contract for the construction of a 1-story, 60x175-ft. factory on East 2nd Ave. Estimated cost, $45,000.

WARREN—City has awarded the contract for the construction of a 6,000,000 gal. per day addition to present filtration plant. Estimated cost, $210,000.

South Dakota

GROTON—The Bd. Educ., School Dist. 33, is having plans prepared for the construction of a 2-story, 118x147-ft. high and grade school. A chemical laboratory will be installed in same. Estimated cost, $200,000. E. Krueger, pres. E. F. Broomhall, 710 Alworth Bldg., Duluth, Minn., archt.

RAMONA—The Bd. Educ. is having plans plans prepared for the construction of a 2-story, rein.-con., brick and tile high school. A chemical laboratory will be installed in same. Estimated cost, $150,000.

WATERTOWN—The Bd. Educ. is having plans prepared for the construction of a 3-story, 152-178-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $250,000. M. Herzel, clk. Tyrie & Chapman, archts. and C. L. Pillsbury Co., engrs., 1206 Second Ave., S., Minneapolis, Minn. Noted Dec. 22.

Vermont

WINDSOR—The Windsor Fdry. Co. had plans prepared for the construction of a 1-story, 115x252-ft. foundry. Waldron & Van Winckle, 37 Wall St., New York City, archts. and engrs. Noted Dec. 29.

West Virginia

ST. ALBANS—The St. Albans Light & Power Co., Charleston, plans to construct a filtration plant here. Estimated cost, $75,000. A. Campbell, gen. mgr.

Wisconsin

ST. CROIX FALLS—Bd. Educ. will receive b'ds in the spring for the construction of a 2-story, 53x90-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $85,000. J. B. Stevenson, clk. W. L. Albam, 347 Endicott Bldg., St. Paul, Minn., archt. Terry & Schulte Engr. Co., 486 Endicott Bldg., St. Paul, engrs.

Ontario

LONDON—E. V. Buchanan, engr. Pub. Utilities Comm., Hydro Bldg., plans the construction of a deferrization plant in connection with the water-works system and is in the market for deferrization equipment.

LONDON—Utilities Bd. has awarded the contract for the construction of a filtration plant to remove iron from the water to Permutit Co., 440 Fourth Ave., New York City. Estimated cost, $40,000.

Quebec

DELSON—The Delson Brick Co., Montreal, will construct a plant here and install equipment.

MONTREAL—F. L. Ross, 7 York Lane, Cote St. Paul, plans to construct a 1-story brick and steel plant for the making of sirup. Estimated cost, $25,000.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its annual meeting Feb. 21 to 24 at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS is holding its spring meeting Feb. 14 to 17 in New York City.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 and 17.

AMERICAN PAPER & PULP ASSOCIATION will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, New York City, April 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

NATIONAL PETROLEUM CONGRESS will meet at the Hotel Baltimore, Kansas City, Mo., March 22 to 25.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: March 11, American Chemical Society; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

Manufacturers' Catalogs

ACHESON GRAPHITE CO., Niagara Falls, N. Y., is distributing its new catalog on "Acheson Electrodes in Use." It contains photographs of a few of the furnaces in operation, which were chosen as each is typical of the class it represents and the kind of work it is doing. In reference to the pictures of brass furnaces only the arc type or those using electrodes are shown. There are also brass furnaces using Acheson resistor for the heating element.

THE FOAMITE FIREFOAM CO., New York City, is now issuing a monthly magazine called *Industrial Fire Chief*, which is devoted to the advancement of fire-protection engineering. The issue for January, 1921, is vol. 1, No. 4. Well-illustrated articles are included, together with a section on "The Day's Mail," which comprise letters from users of the company's product.

RUGGLES-COLES ENGINEERING CO., New York City, calls attention to Catalog 16, which describes the various types of driers. This company has designed eight distinct types of drying machines, which cover the field of drying as completely as possible. Each type is described and the use to which it may be put, together with illustrations of them.

PITTSBURGH INSTRUMENT & MACHINE CO. has just issued a pamphlet on a continuous and alternating impact testing machine to be used in connection with the testing of airplane, automobile and other machine parts which are exposed to shock.